connection is made with the Sea Beach line to Coney Island and a two-track line from 65th St. to the present terminus at 86th St.

Work on the remainder of the Fourth Ave. subway from 43rd St. to 86th St. was completed within the past year, including the connection with the Sea Beach line, making possible the operation of the Fourth Ave. subway. Two of the four tracks are used. On June 19, 1915, through operation was commenced from the Chambers St. station in the basement of the Municipal Building, Manhattan, to Coney Island by way of the Center St. loop, Manhattan Bridge, Fourth Ave. subway and Sea Beach railroad. During the rush hours six-car trains are now operated on a 4-min. headway. Trains have recently been operated south of 65th St. to 86th St.

Operation of the Center St. loop had previously been commenced, on Aug. 19, 1913, over the Williamsburg Bridge, connecting with the existing Broadway elevated line in Brooklyn.

Within the past year the contract work for the alteration of the old Steinway tunnel to permit the operation of subway cars was completed, and on June 22 this tunnel, officially known as the Queensboro subway, was put into operation from the station under 42nd St. near Lexington Ave. to Jackson Ave. station in Queens. Operation has recently been extended to the Hunters Point Ave. station. The service consists of two-car trains on 2-min. headway during rush hours, and single cars are operated at longer intervals during the rest of the day.

The work of third-tracking the Second, Third and Ninth Ave. elevated lines in Manhattan and the Bronx, a part of the Interborough's system, was completed within the past year by the company, and recently the new express service has been put into operation.

Extensive work of reconstruction and extension of existing elevated lines in Brooklyn is in progress by the New York Municipal Railway Corporation, and within the past year a considerable amount of this work was finished. In February, 1915, a new elevated line to Lutheran cemetery was opened, and in September, 1915, an elevated extension out Liberty Ave. to Lefferts Ave. was also put into operation.

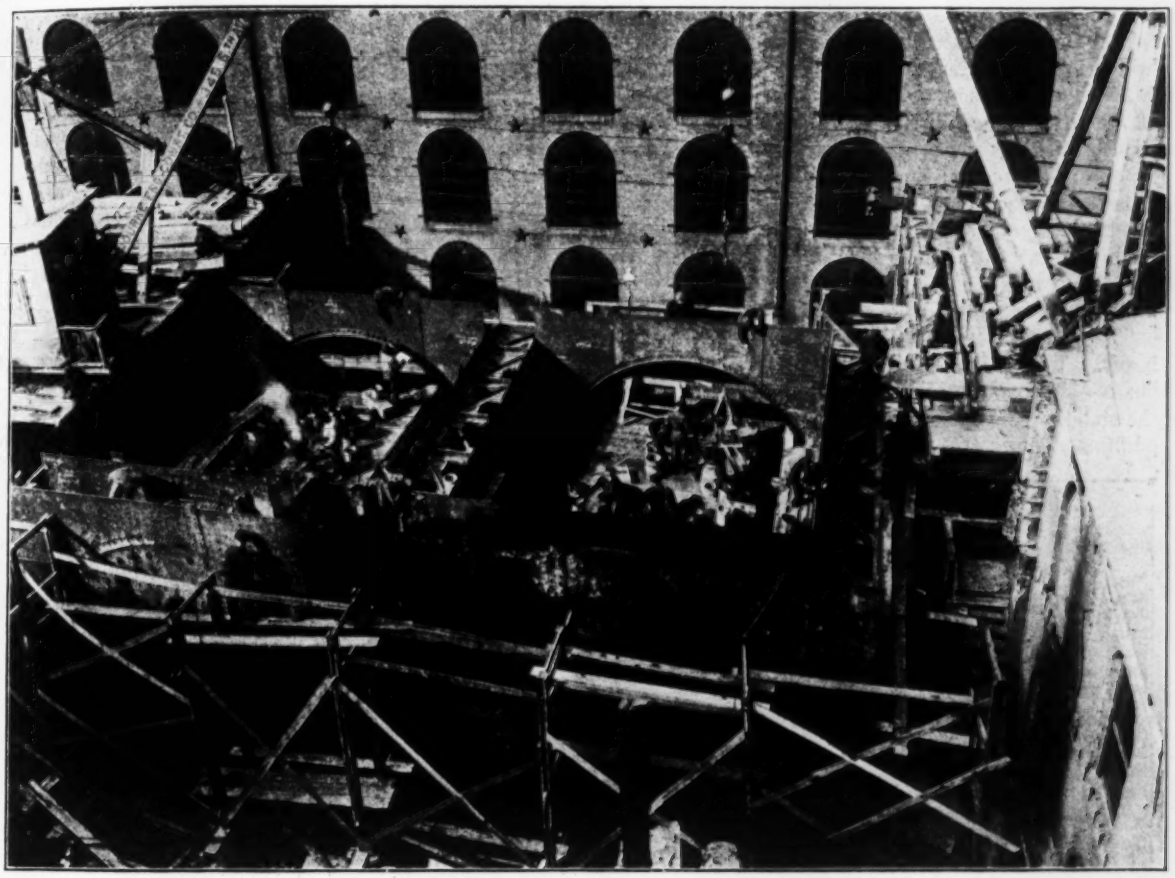


FIG. 9. SINKING CAISSON FOR TUNNEL SHAFT AT FURMAN AND CLARK ST.

When the System Will Be Completed

The greater part of rapid-transit work will have been completed by the end of 1917. Operation of portions of the system, however, is contemplated before that time. It is expected that some of the new lines will be placed in operation during the present year, such as the elevated extension of the West Farms branch of the present subway along White Plains Road from 180th St. to 241st St. in the Bronx; the new elevated lines in the Borough of Queens from the Bridge Plaza to Astoria and to Corona; and the New Utrecht Ave. line as far as the Sea Beach railroad.

The design and construction of the various lines in the Dual System are under the direction of Alfred Craven, Chief Engineer, Public Service Commission.

Field and Office

Century-Old Floating Bridge Sinks Deeper Each Year

A floating bridge built in the first decade of the nineteenth century is still in service across Glenmere Pond on the main road between Lynn and Salem, Mass. The bridge is a timber structure 28 ft. wide and originally 511 ft. long, but now reduced to about 400 ft. by filling at the shores. As built it was a solid timber structure about 5 ft. thick made up by spiking together successive layers of longitudinal timbers. As these timbers became waterlogged they gradually sank and as they sank new planks were year by year added to the roadway until now the bridge is reported to be about 28 ft. thick and extends well down into the bog bottom, which was the original impediment to bridge piers or pile footings.

The crossing is now much used and the traffic is very heavy. Under the heaviest loads—such as well-filled busses—the roadway disappears in water, but otherwise the stability seems assured. Frequent renewals or rather additions, however, make a new bridge economical.

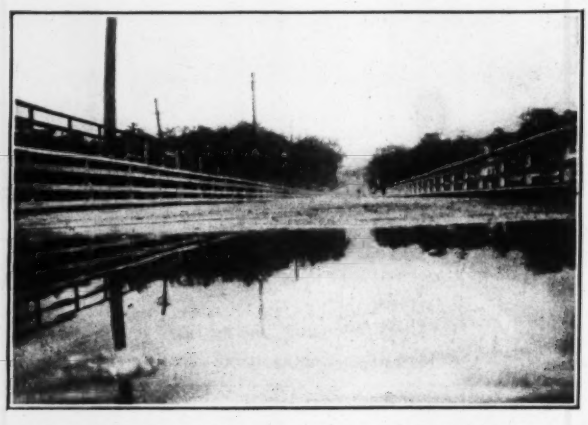


FIG. 1. SUBMERGED ROADWAY OF GLENMERE POND BRIDGE

Coke Concrete Found Strong After Seven Years

By Kenneth A. Heron*

About seven years ago the writer was called upon to underpin the front wall of a battery of coke ovens at Segundo, Colo. It has been the custom to "pull" the ovens by hand previous to that time, and certain changes were necessary to be made in the wharf level to provide for the installation of coke-pulling machines. In order to lower the wharf level 2 to 3 ft. as planned, it was required to extend the face wall lower with a suitable foundation, as the original construction did not contemplate the removal of the material in front of the wall so as to expose its toe. The underpinning was to extend at least 2 ft. below the new wharf level and, being thicker than the old wall, was to be carried up the face a short distance.

Suitable sand or gravel could be obtained only by shipping in from outside points at considerable expense. There was available, however, at the plant large quantities of coke breeze—waste coke too small for furnace purposes—ranging in size from dust to about 1 in. Coming directly from the ovens, it was clean and free from vegetable matter; and it was accordingly adopted for use as concrete aggregate, in the proportion of six parts coke to one part cement, for the new footing.

The mixture when wet formed a mass of brownish color weighing about 80 lb. per cu.ft. It was very easily mixed, handled and placed in the forms and when hardened and brushed with cement grout resembled ordinary sand and rock concrete, although not obtaining as hard a set. A week or ten days after placing, however, it would resist quite a sharp blow without fracture and carried the load of the heavy wall without any appreciable settlement.

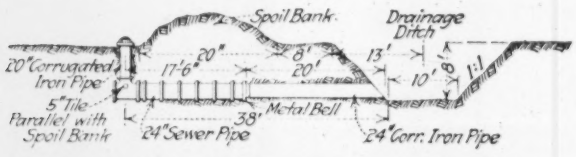
An examination recently showed that the mass had hardened to a degree approaching the strength of the

*Chief Engineer, Goose Lake Valley Irrigation Co., Lakeview, Ore.

FIG. 2. OLD FLOATING BRIDGE ACROSS GLENMERE POND, NEAR LYNN, MASS.

should be placed at such a depth that it can be used as an outlet for the tile. After the tile system has been installed, the catchbasin will serve to admit surface water during excessive rainfalls.

The spoil bank, after one or two years' weathering, should be plowed down, leveled and sown in grass and



DITCH OUTLET FOR SURFACE WATER, WITH CONNECTION FOR TILE SUBDRAINS

the grass permitted to grow from the outer edge of the spoil bank down the ditch slopes. The spoil banks should be left high enough to prevent surface water from flowing over them, causing all such water to enter the ditch through the inlet. They can be either fenced and pastured or used as meadow lands. Local conditions and the nature of the soil to a certain extent will determine which is the more desirable.

The tile lines running parallel to the open ditch and along the outer edge of the spoil bank are for the purpose of intercepting groundwater and preventing its entering the open ditch through the slope. They tend to keep the slopes dry and thus decrease the caving and slipping that occur where groundwater enters open drains through porous strata in the slopes.

Screen Cart for Broken Stone

The screening cart or traveling screen shown in the accompanying illustration is designed for use where old macadam paving is being torn up and used in making concrete for a pavement or foundation course. In such work the old stone is often hauled to a dump and wasted, and if hauled to and from a screening plant the cost may be almost as great as for new stone. With this cart, however, the old stone is screened while being hauled from the road to the stockpile at the concrete mixer, and a haul of the length of about a block is sufficient to clean the stone.

The screening drum is 40 in. diameter and 45 in. long, made of heavy wire netting with 1-in. mesh. Its capacity is 1⅛ cu.yd., but the load is ⅔ to ¾ yd. to allow free movement of the stone. The door is 17 in. wide, extending the full length of the drum. Loading is done best by forks, thus giving a preliminary screening. The drum is mounted between a pair of 5-ft. steel wheels with 6-in. tread and revolves with them. The machine is 6 ft. wide over the frames and weighs about [illegible] lb. (including the pole). The driver stands on a [illegible] or footboard, at the rear.

The illustration shows one of the carts used on work in Chicago, the cart being on the stockpile and ready to dump. This machine is built by the Briggs & Chicago Co., 108 S. La Salle St., Chicago, Ill.

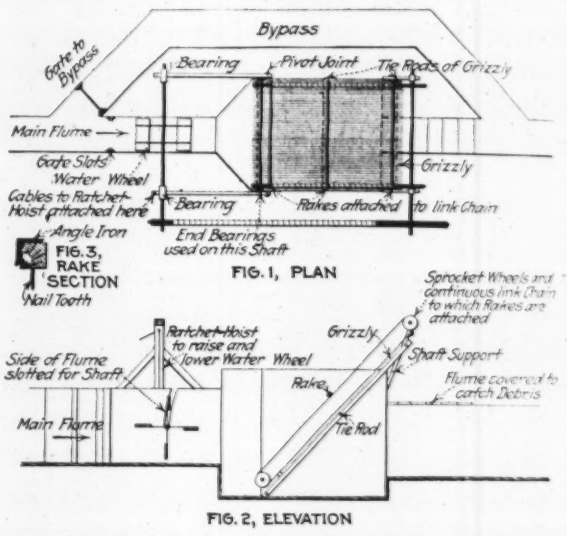
SCREENING CART FOR CLEANING OLD MACADAM STONE

Self-Cleaning Flume Screen

By H. W. Keith*

Where water for mining, irrigation, power or other services is conveyed by means of flumes, the paramount problem, generally, is the removal of the floating débris. The writer has found the self-cleaning screen described herein very satisfactory in the solution of this problem.

The first step in the installation of the screen is the construction of a bypass flume (Fig. 1) around the location



FIGS. 1 TO 3. SELF-CLEANING SCREEN FOR FLUMES

of the screen. About 10 ft. below the entrance to the bypass the flume is enlarged to almost three times its width. The length of this widened portion, or screen box, depends upon the angle at which the screen is inclined therein. The bottom of the screen box is placed at an elevation about 3 ft. below the bottom of the flume at the entrance of the latter to the screen box. The bottom elevation of the flume, on leaving the screen box, should be about 2 ft. above the bottom elevation of the latter, thereby forming a settlement basin. This basin is not absolutely necessary, but it has been found beneficial, as it catches sediment and the like after the water has passed through the screen.

A simple undershot waterwheel is placed in the flume between the entrance to the bypass and the screen box. The wheel—the blades or paddles of which are made nearly equal in length to the width of the flume, leaving only a practical clearance—is mounted on a shaft; the sides of the flume are slotted to admit the latter (Fig. 2). A bearing on each side of the flume supports the wheel (Fig. 1) and is mounted on a strip of timber, which extends to the side of the screen box and is held in position there by a pivot joint. The whole is supported at the oppo-

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coke, and, while chipped and broken off in places exposed to heavy wear, was serving its purpose very well.

Since this work was done, coke concrete has been used for a number of other purposes in some of the other southern Colorado coal and coke plants. At Tabasco one of the fuel companies has erected a large number of coke-concrete blockhouses, and I am informed that they are much drier and more satisfactory than are stone-concrete block structures. The cost of making the blocks was about two-thirds the estimated cost of stone-concrete blocks.

Cornice Runways for Swinging Scaffolds from Buildings

The maintenance of large buildings, such as offices, stores, hotels, etc., involves periodical cleaning, painting and pointing, and also the washing of windows. This work is done usually from swinging scaffolds suspended from hooks or timbers on the roof. Where these supports are of a temporary character, they involve delay and trouble in rigging. Two methods of providing permanent supports, which give greater facility and economy, have been developed by Holabird & Roche, architects, of Chicago.

The building for the John Taylor Dry Goods Co., at Kansas City, Mo., is equipped with a permanent runway along the cornice, upon which travel trolleys from which the scaffold rigging is suspended, as in Fig. 1.

The runway is an angle 2½x2½x⅜ in., attached to the outer ends of T-bars that are spaced 5 ft. apart and have their inner ends anchored to the steel framing of the building. The trolley is composed of steel bars carrying a pair of 4½-in. grooved wheels. To the lower ends of the bars is riveted a plate for the attachment of the scaffold rigging. The inner end of the trolley frame is bent to engage a 1x1-in. guard angle, so that the trolley cannot be pulled over. This device is designed to carry a test load of 1,000 lb. at any point.

The Mandel Brothers Building, in Chicago, has both fixed and movable supports for the scaffolds. For the former there is a 3x4-in. runway angle carried by cantilevers of 5-in. H-beams attached when required to the steel frame of the cornice and roof. This equipment is shown at the top in Fig. 2.

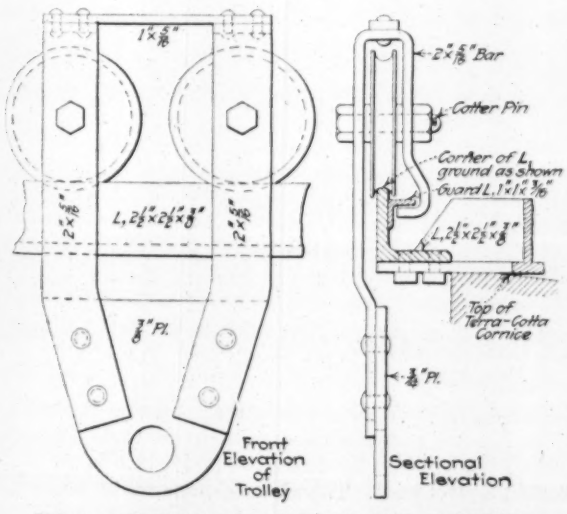


FIG. 1. RUNWAY AND TROLLEY FOR SWINGING SCAFFOLDS ON THE TAYLOR BUILDING

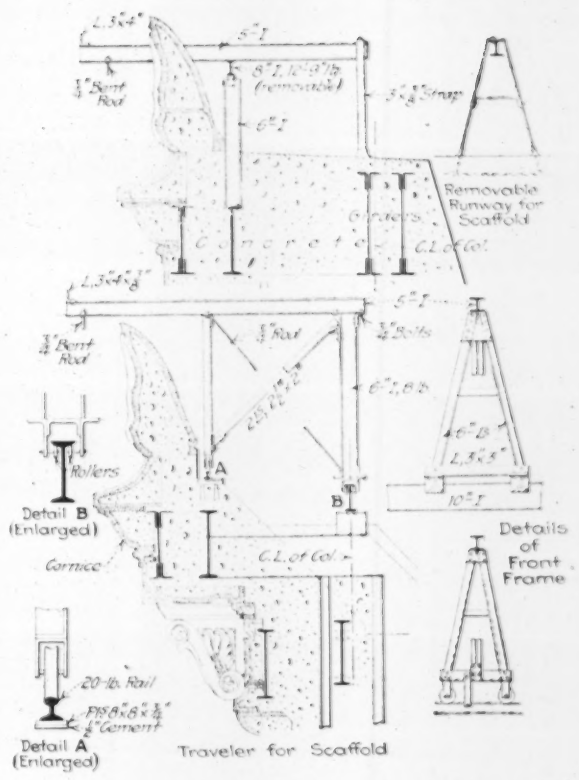


FIG. 2. SUPPORTS FOR SWINGING SCAFFOLDS ON THE MANDEL BUILDING

The upper drawing shows a removable runway. The lower drawing shows a traveling carriage

For the movable supports, on a newer portion of the building, there is behind the cornice a track on which travel carriages having cantilever beams that project over and beyond the cornice, as shown in the lower drawing of Fig. 2. The cantilevers form attachments for the scaffold rigging. The carriage is composed of two A-frames, connected by bracing and carrying the cantilever beam. The forward frame has grooved rollers running on a 20-lb. rail, while the rear frame has two pairs of 3-in. rollers riding under the flanges of a 10-in. I-beam and so forming the anchorage.

Surface-Water Ditch Outlet

The surface-water intake and tile outlet protection shown herewith are designed to admit surface water into an open ditch without eroding the banks or carrying off surface washings from adjoining fields. Ordinarily, surface water would be held back by the spoil bank or would cut through it and through the berm. This arrangement was devised by John T. Stewart, Chief of the Division of Agricultural Engineering at the University of Minnesota, St. Paul, Minn.

Corrugated metal pipe is used on the outlet end. This is in a long section and will not become displaced by the flow of water in the ditch. The grade is 1 in. in 10 ft. As nearly all large open ditches are constructed with a view to tile drainage of the adjoining lands, the pipe

site end by two small flexible cables, one attached to each bearing timber and connected overhead to a ratchet hoist (Fig. 2), by means of which the wheel can be raised or lowered according to the amount of water flowing.

A screen or grizzly, is placed in the screen box. It is composed of a number of flat strips of iron (4 × ¼ in. was found most effective) separated by washers, giving any desired opening, and bolted together with rods through the top, middle and bottom. This grizzly should occupy the entire width of the screen box. One end of the grizzly is placed on the bottom of the upstream side of the screen box (Fig. 2) and inclined at any satisfactory angle. A shaft is placed at the upper end, about a foot beyond the end of the grizzly and at a sufficient height above the plane of the face of the latter so that the two sprocket wheels placed on the shaft about 4 or 5 in. in from its sides will be nearly tangent to its face. A similar shaft is placed at the bottom end, so that the sprocket wheels will allow the rakes to come in contact with the grizzly about 6 in. above the bottom end. The corresponding sprockets on both sides are connected by a continuous chain belt to which rakes are attached at 6-ft. intervals.

The rakes are strips of wood, equal in length to the width of the grizzly, with nails driven through so as to fit into the slots and act as teeth. The strip is then weighted with a strip of angle iron (Fig. 3), the rakes being attached at either end by means of this angle iron to the link chains.

The upper shaft is connected to the waterwheel by means of a sprocket wheel and link belt and is geared to draw the rakes across the grizzly at the rate of about 4 ft. per min. The flume must be covered for a short distance below the screen box, in order to catch the débris.

Protecting Survey Monuments in Phoenix

City survey monuments of a satisfactory type have been developed in Phoenix, Ariz. The street lines are marked generally by center-line monuments or by offset lines from the center line which bring the monument in the street area. In paving the streets great care is taken not to disturb the monuments. First their location is ascertained, and then a man is stationed to watch that they are protected from the roller, wagons, etc. About 4 in. of the head of the monument is uncovered, and a concrete base 9 in. deep is formed around the top of the stone, leaving about 1½ in. of soil all around. A square cast-iron box is set in this concrete base. The pavement may then be constructed around the cover box without injury to the stone. The object of the 1½ in. of soil around the stone is to provide for the expansion and contraction of the pavement. It was found, however, that water getting in here sometimes resulted in displacing the stone, so a seal of 1½ in. of asphalt was added.

The boxing of the monuments as described is made a part of the paving contract. The record of the monuments, which serve for both line and bench marks, is kept in a special book. The city engineer is James B. Giraud.

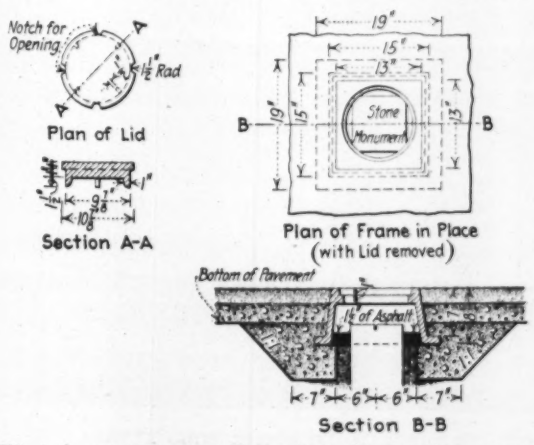
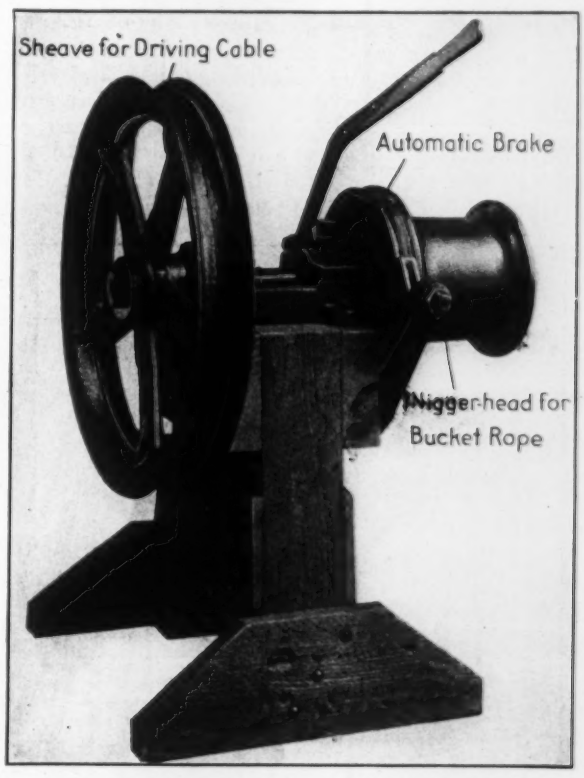


FIG. 1. CITY SURVEY MONUMENT AND BENCH MARK, PHOENIX, ARIZ.

Safety Brake for Hoists

In sinking the wells (locally known as "caissons") for the concrete foundation piers of large buildings in Chicago, a general method is to place over each well a hoist having a niggerhead for the manila rope of the bucket and a grooved sheave for a wire driving cable. The cable serves a series of hoists and is operated from a drum with a steam or gasoline engine or electric motor.

The method of operation is to wrap the driven cable once around the sheave, which is keyed to the shaft. The operator stands on the niggerhead side of the hoist and takes as many wraps of rope around the niggerhead as are necessary to lift the load. In case of fracture of the driven cable the automatic brake is set and prevents the bucket from dropping on the men at the bottom of the well. The lever is for applying the brake by hand in case the bucket rope gets fouled. This locks the niggerhead and the sheave, and the driving cable will then slip on the sheave. This safety device is used on hoists made by the Thomas Elevator Co., Chicago.



FOUNDATION HOIST WITH SAFETY BRAKE

Piledriving Details on the Yolo Bypass Trestle

Hard driving was experienced in putting down the precast piles of the concrete highway trestle across the Yolo bypass in California, the construction of which is only just completed. The 2,940 concrete piles required for the structure were cast in a yard adjacent to the trestle and were hauled to the work by gasoline locomotives. Fig. 1 shows the piledriver and derrick about to take hold of a pile and swing it between the leads. The method of handling was to pick the pile up at the point by the boom fall line and at the head by the pile line. The pile then was swung clear of the track and placed in the leads by slacking off the boom line and picking up on the pile line.

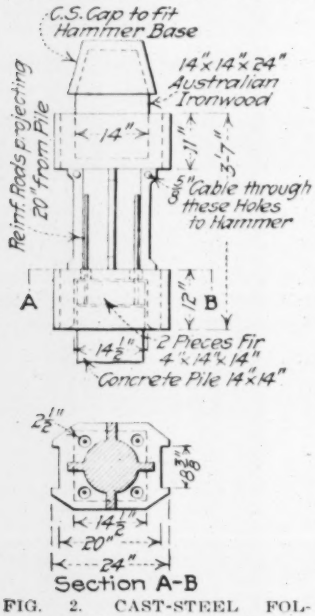


FIG. 2. CAST-STEEL FOLLOWER USED WITH STEAM HAMMER

A No. 1 Vulcan steam hammer was used for driving. This machine had a 3½-ft. drop and a 5,000-lb. ram, equipped with a cast-steel follower (Fig. 2). Hammer and follower weighed 12,500 lb. The piledriver was operated by an 8¼x10-in. American hoisting engine, but an additional 35-hp. boiler was found necessary to supply sufficient steam to the hammer for the hard driving. A summary of the piledriving results is as follows:

Pile Length, Ft.	Piles Driven	Number of 8-Hr. Driving Shifts	Average Piles per Shift
32	846	35	
35	1,114	69	
40	527	41	
45	226	25	
50	227	28	
	2,940	198	

It was required that the piles should be driven to grade if possible, without injury to the pile or the driving equipment, and that driving be continued until the penetration was not more than ⅛ in. per blow. These requirements made it necessary to cut off or splice many concrete piles after driving, in spite of test piles.

SPLICING OF CONCRETE PILES

Length of Splice Ft. In.	Ft.	Piles Spliced	Ratio of Piles Spliced to Piles Driven, %
.. ..	to 1	98	3.33
1 1	to 2	105	3.57
2 1	to 3	35	1.19
3 1	to 4	12	0.41
4 1	to 5	7	0.24
5 1	to 6	1	0.03
6 1	to 7	2	0.07
7 1	to 8	1	0.03
		261	8.87

CUTTING OF CONCRETE PILES

Length Cut Off Ft. In.	Ft.	Piles Cut After Driving	Piles Cut Before Driving	Total Piles Cut	Ratio of Piles Cut to Piles Driven, %
.. ..	to 1	40	..	40	1.36
1 1	to 2	49	..	49	1.67
2 1	to 3	37	..	37	1.26
3 1	to 4	18	..	18	0.61
4 1	to 5	15	15	30	1.02
5 1	to 6	16	14	30	1.02
6 1	to 7	16	32	48	1.63
7 1	to 8	4	1	5	0.17
8 1	to 9	3	27	30	1.02
9 1	to 12	5	..	5	0.18
		203	89	292	9.94

Ratio of piles cut and spliced to piles driven, 19[illegible]

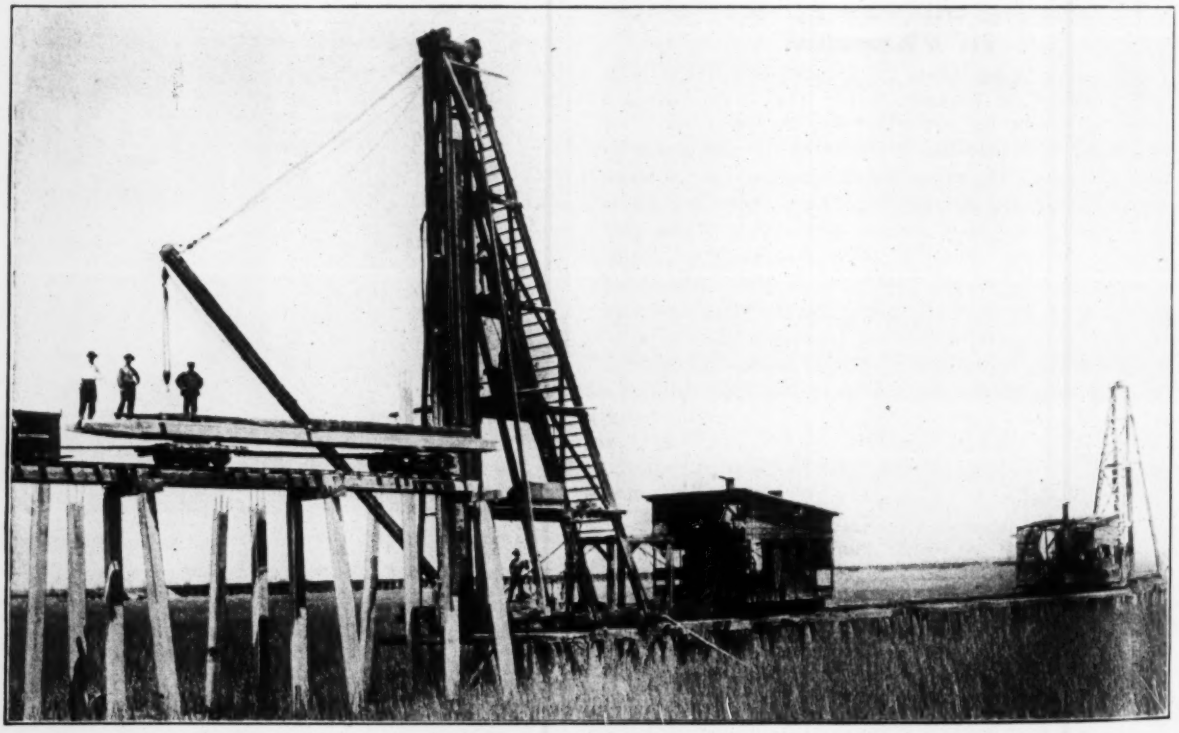


FIG. 1. ERECTING THE UNIT-CONSTRUCTION CONCRETE TRESTLE OVER THE YOLO BYPASS
After driving a bent of concrete piles, the larger piledriver was pulled back one span. The temporary wood piles in front of the machine were pulled and floated ahead to be redriven by the smaller piledriver

The trestle was built for the California Highway Commission by the Graff Construction Co., Seattle, Wash.; Horace W. Holmes, Superintendent.

Two Railing Details for Concrete Bridges

An open concrete railing—neither balustrade nor parapet—is used on many of the recent concrete bridges built by the Ohio Highway Department. It is called "Type D" railing (Fig. 2) and is shown on a standard sheet.

The railing is considered very successful as to appearance, especially on bridges whose waterway height is small. It is easy and cheap to build. The lowest price

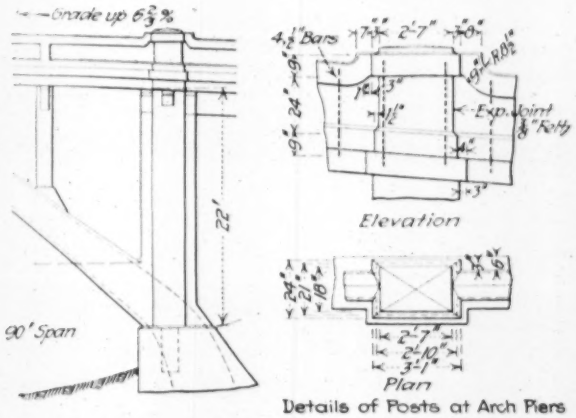


FIG. 1. TREATMENT OF RAILING AT PILASTER ON HEAVY GRADE, WILLS CREEK BRIDGE, CAMBRIDGE, OHIO

obtained last season was less than $1 per lin.ft. The open space, 15 in. high, is not regarded as dangerous on country road bridges.

The bottom rail is molded directly on the top surface of the coping or spandrel wall, but only the posts are bonded in by steel. The top-rail lengths are precast, and the posts are molded around them. Expansion of top rail in post is provided at intervals (not at every post).

Another interesting railing detail used by the department is shown by Fig. 1, from the Wills Creek bridge in Cambridge, a 90-ft. open-spandrel arch now under construction. The roadway is on 6⅔% grade and thus presents the old difficulty of joining a sloping rail to a post whose top is horizontal. At such a junction the opposite sides of the post project unequal distances above the rail unless the line of the railing is given a horizontal jog at the post, an expedient that in most cases is not practicable. The unsatisfactory appearance of the difference of heights of projection is neatly masked, in the Wills Creek bridge, by swinging the top line of the rail up to the post by a curve, as shown in the sketch.

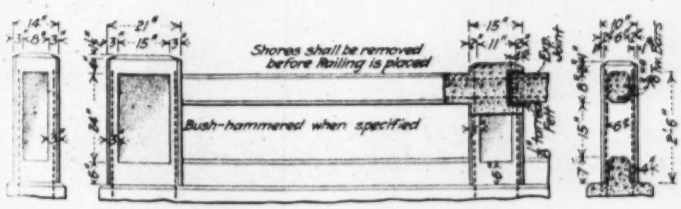


FIG. 2. OPEN RAILING USED ON OHIO ROAD BRIDGES (TYPE D, OHIO HIGHWAY DEPARTMENT STANDARDS)

NOTES

Concrete Footing Blocks for Sheeting Braces. A method of bracing the sheeting of retaining-wall excavations without leaving holes in the wall concrete was used in Detroit recently. The pit for a new screen chamber at the city water works required to be sheeted, and this was so placed as to serve as outside form for the wall concrete. To avoid having to leave holes in the concrete at the braces of the sheeting, separately molded concrete blocks of the thickness of the wall were placed against the sheeting and the braces butted against them. The blocks were made with a slight taper, and the largest face was placed against the sheeting. After completion of the wall the blocks were keyed in by this taper.

Notice to Property Holders of Street Improvement. The city charter of St. Louis requires that in advance of all street improvements that are to be paid for by special taxation there shall be held a public hearing at which all interested property holders shall be invited to appear and express their views on the question of improvement and on the matter of materials to be used. It further provides for giving official notice for such hearings in the newspapers doing the city

STREET-IMPROVEMENT NOTICES SAVE TROUBLE

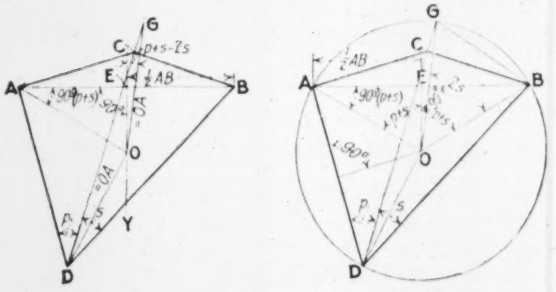
printing. As these notices usually appear in the advertising section and are rarely read, the city has this year carried out a scheme of special notification by having placards posted at each intersection of the street under construction.

In addition to the notice of the hearing, the placards carry an estimate of cost of the materials which the city is willing to consider. This estimate is contained in the oblong in the lower left side of the placard. Any property holder knowing the frontage and area of his lot can estimate in advance the cost to himself of each material and come to the hearing thoroughly informed. This procedure always brings out a representative meeting and eliminates any doubt as to the board's being acquainted with the desires of the affected property holders.

The sign shown is printed on heavy cardboard. It is paraffined and slipped into sheet-metal holders,

which are either wired or screwed to a post. The dates and the estimates are changed for each hearing, and the printed signs are used a number of times.

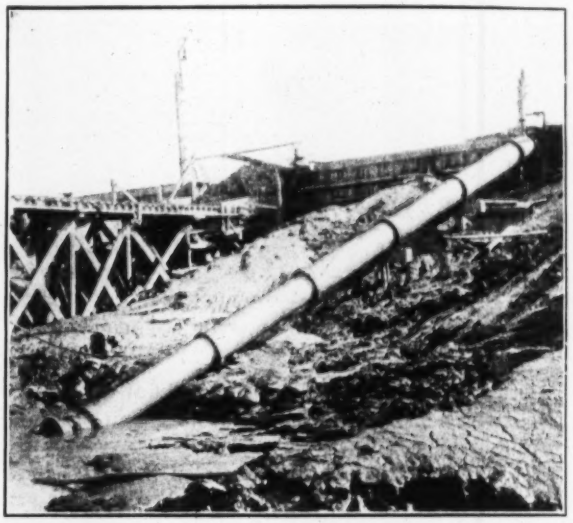
Three-Point Problem; A Graphical Solution—The location of a point fixed by observed angles to three known points —the well-known three-point problem—may be plotted without any calculation whatever, more accurately and easily than by the three-arm protractor or transparent paper. Construction: Let A, B, C, Fig. 1, be the three known points, and D the unknown point at which have been observed the angles p and s subtended by AC and CB. Plot the points A, B and C on the map and calculate or scale distance AB. Bisect AB at E and draw perpendicular EY. At A lay off from AB the complement of (p + s) with ordinary protractor, as angle BAO, intersecting EY at O. From O draw line OG equal to OA and making an angle with the perpendicular equal to (p — s). The point D is on line GC and at a distance from O equal to AO. Demonstration: In Fig. 2 the perpendicular bisectors of AB and AD meet at the center of a circle passing through AB and D. Drawing the radii OA, OB, it is seen that triangle OAB is an isosceles triangle, so that angle OAB = angle OBA. The angle AOB is twice the sum of the angles p and s since the chord AB subtends at D, on the circumference, only half the angle that it subtends at the center O. Hence, each of the angles OAB and OBA is the complement of (p + s). Producing DC to the circumference at G and drawing BG and radius OG, it will be seen that angle GOB is twice s, because the chord BG subtends angle GOB at the center and angle GDB = s at the circumference. But BOE is already found equal to p + s, so that angle p + s — 2s, or p — s, will be angle GOE, giving the direction of the point G. If the sum of angles p and s is greater than 90°, the center of the circle lies above AB, but the demonstration is the same. If 2s is greater than p + s, the angle EOG will be to the left of the perpendicular EY.—C. K. Averill, 34 Warburton Ave., Yonkers, N. Y.



SOLUTION OF THREE-POINT PROBLEM

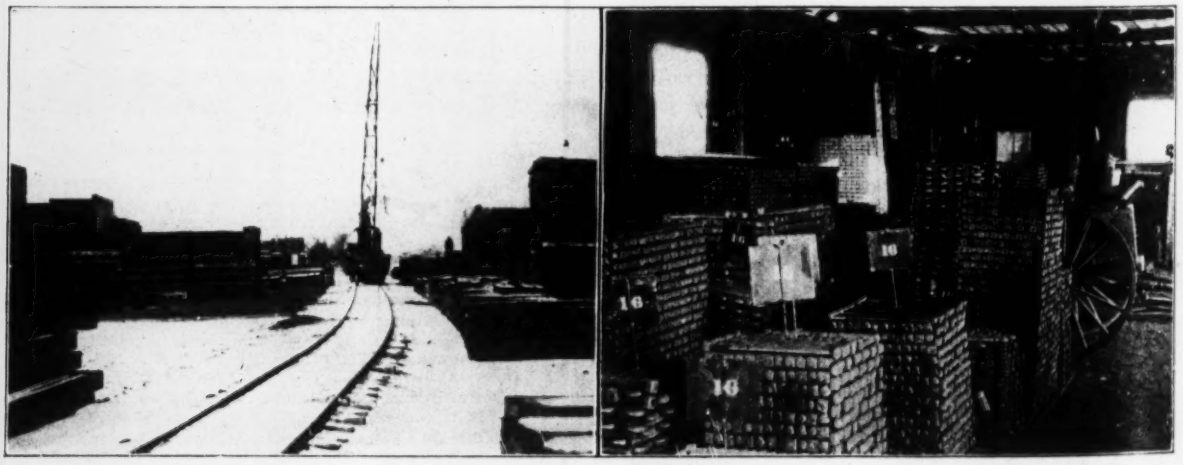
A Neat and Systematic Material Yard is that of the Atchison, Topeka & Santa Fé Ry. at Arkansas City, Kan. Unlike other model material yards, this one is a development from a single siding and was not originally intended for the purpose it now serves. All lumber is neatly piled and arranged in alleys fronting a track. Each pile of lumber bears a sign in black and white, giving all the dimensions of the sticks in that pile. The sizes are systematically arranged so that all of similar dimensions are adjacent. Treated (creosoted) timber is kept in a separate part of the yard. The yard also contains ties, piles, poles, etc. Bolts, pipe and other hardware are stored in houses. The bolts, as one of the illustrations shows, are neatly stored in square bins, each pile bearing a sign card of the size of the bolts in that pile. Throughout the yard are planted disk car-spotting signs. When a loaded car comes in or a car is to be loaded, the superintendent of the yard has merely to give the track crew the nearest spot number to the pile. This system reduces the "pinching" of the cars in the yard to a minimum. There is no plan of the yard, as the foreman carries in his head the location of the various articles. Sufficient material of every kind is kept on hand so that any bridge order can be filled complete and the whole shipment made at one time. There is a locomotive crane constantly in the yard to handle large timbers and piles. Fire protection is provided by a row of city fire hydrants on the south side of the yard. There are also two hose houses and outfits.

Large Siphon To Flood Coffer-Dam for Protection—At the construction coffer-dam at lock and dam No. 43, Ohio River, high water rises well above top of coffer-dam. The danger of sudden flooding of the works is forestalled by a large steel-pipe siphon for filling the coffer-dam in rising water.



SIPHON FOR FILLING COFFER-DAM IN RISING WATER; LOCK AND DAM 43, OHIO RIVER

The short, or intake, leg of the siphon is shown in the photograph. At the summit there is a steam injector for the siphon. The device was installed last year and has proved a success. Major John C. Oakes is engineer officer in charge.



EXTERIOR AND INTERIOR VIEW OF THE MATERIAL-STORAGE FACILITIES OF THE ATCHISON, TOPEKA & SANTA FE RY. AT ARKANSAS CITY, KAN.

Editorials

Why Hoop Concrete Beams?

In one of the huge reinforced-concrete girders carrying the new balcony in the rebuilt theater at Wilmington, described on page 834 of this issue, the designer thought it desirable to increase the compressive strength by inserting a spiral hoop in the upper part of the girder. This device is not new, but it is rarely resorted to, probably because of its doubtful utility. In commenting upon such a use of spiral reinforcement in 1908, *Engineering News* said editorially:

> Because hooped columns have, in a few published tests, shown a marked increase in strength over the straight reinforced columns is no reason for attempting to utilize a similar construction in beams. The tests show that there is no magical property in a spirally wound hoop which can increase the strength of inclosed concrete, but that it is probable that the higher loads withstood by concrete so reinforced are due to the tensional strength of the hooping steel brought into play by the concrete expanding laterally (according to the Poisson ratio) under the load which simultaneously causes it to compress in the line of application of stress. This preliminary compression in the upper flange of a hooped beam complicates the distribution of the moment between the concrete and steel and renders extremely doubtful the utility or at least the economy of so reinforcing a beam. To get the full strength of the concrete the steel must be designed, far above its economical proportion, to take care of this primary deflection in the concrete, always providing that the shifting neutral axis and modulus of elasticity in the concrete do not so complicate the stresses as to make exact analysis impossible.

In the eight years that have elapsed much has been learned about reinforced concrete, but nothing which would warrant any variation in the criticism then made. Hooping of columns adds toughness and raises the failure point—both of which increase the factor of safety. Hooping of beams may add toughness, but the raising of the failure point is, to say the least, doubtful. It is probable that the spiral steel could be used longitudinally to much better advantage.

Estimating Armor-Plate Cost in a Government Plant

The Senate bill appropriating $11,000,000 for the construction of a Government armor-making plant has not yet passed the House of Representatives, although it has been favorably reported by the House Committee in charge. While its passage by the House is probable, in view of the action taken by the Democratic caucus reported in our issue of Apr. 6, the questions involved in the engineers' estimates, on which this Congressional action is based, are of sufficient general interest to deserve discussion.

According to the testimony before the Senate Committee on Naval Affairs, the estimates made by Admiral Strauss, Chief of the Bureau of Ordnance, are for the construction of a Government armor plant with a capacity of 20,000 tons per annum and show that the *operating cost* of such a plant, run at full capacity year in and year out, would be $230 per ton of armor produced. This estimate is for operating cost only and contains no allowance for interest on the cost of the plant nor for taxes, insurance, depreciation and *obsolescence*.

It deserves emphasis at this time, when comparative estimates are frequently called for between the cost of Government, state or municipal operation of an enterprise and private operation, that the two computations should be made on the same basis.

Government operation has a certain advantage over private operation, unquestionably on account of the lower rate of interest at which the Government can obtain capital; but this rate of interest should always be included in the comparison. Furthermore, the rate of interest charged on a Government plant should be the natural rate and not some artificial rate that the Government may be able to obtain by the exercise of its special powers.

For example, because Federal Government bonds sell at a price that yields only 2% on the investment, it does not mean that the Government can actually borrow money at that figure in the open market. It means that, because of the freedom from taxation and because of the use of the bonds as a basis for bank circulation, an artificially low price for them is created. For this artificially low price, however, the Government and the public it represents must pay eventually in some other way. If, for example, a city issues bonds that are free of taxation to build a street railway and sells the bonds at a lower rate of interest because they are free of taxation, then that city or some other city will not receive taxes on the capital represented by those bonds which it would have received had the bonds been issued by a private corporation.

It must be evident that if a large amount of property in a locality is owned by the Government and is therefore free of taxation, the burdens of taxation must be heavier on the private property remaining. In comparing, therefore, public ownership with private ownership of a public utility something must be charged for taxes on the property in the case of the public-owned plant, not because such taxes will actually be paid out of its earnings, but because the public will lose the amount which it would receive were the plant owned by a private corporation.

Concerning the items of depreciation and insurance, there can be no question whatever that they exist just as much in the case of a Government plant as of one under private ownership. The Government may of course properly carry its own insurance, but the risk of loss from fire is there, nevertheless, and is as much a proper part of the expenses of operation as is the risk of injury to workmen and the compensation that must be paid on account of such risk.

But in considering the proposed Government armor-plate plant special attention ought to be paid to the matter of obsolescence. The annual charge for depreciation refers to the period of time at the end of which the plant will cease to become useful because of physical deterioration. The annual charge for obsolescence refers to the time at the end of which the plant will cease to be valuable because it is obsolete. There is no doubt that in

most engineering estimates made for private concerns as well as for the Government far too little allowance has been made for obsolescence. If anyone questions its importance in connection with Government work, he would do well to make a tour of Government property located in various parts of the country and see what uncounted millions the Government has invested in the past in works that today are out of date and out of use.

This question is a very practical question in connection with the proposed investment in a Government armor-plate plant. No one is wise enough at the present day to predict with any certainty for how much longer the use of armor on huge floating fortresses, to any such extent as in the past, is to be continued by civilized nations. Nothing can be more certain than that the years immediately before us are to witness most profound changes in methods of warfare and in international relations. No one knows what revolutionary alterations in methods of national defense are to result from the development of the submarine, the airship and the controlled torpedo.

Of course, if the Government were obliged as a matter of national defense to incur this risk of obsolescence, there would be no question as to its duty to do so, be the cost smaller or greater. But the Government has avowedly undertaken to build its own armor-plate plant solely because it has concluded that it can save money by making its own armor on the previously mentioned estimate of $230 per ton for operating expenses instead of purchasing armor from the Bethlehem Steel Co. at its offer of $395 a ton. The Bethlehem Co. has now offered, however, to submit its entire plant, accounts and operations to the Federal Trade Commission and to manufacture such armor as the Government may require at such a price per ton as the Federal Trade Commission, acting as an impartial umpire, may decide to be fair to the Government and to the company. If Congress is governed by business principles and not by politics in dealing with the armor-plate question, it will accept this latest offer of the Bethlehem Co. rather than invest $11,000,000 of the Government funds in an armor-plate plant, which may quite possibly need to be replaced with something very different within a few years after its completion.

Changes in Ocean Carriage

No better illustration could be given of the unprecedented conditions now prevailing in ocean transportation than the statement made last week, in a hearing before the Interstate Commerce Commission, that substantially none of the vessels which were plying between the Atlantic and Pacific Coasts through the Panama Canal at the time it was closed, last October, will be restored to that route now that it is reopened.

The demand for ocean shipping and the rate for ocean freights have so greatly increased during the past six months that the vessels which were making regular trips through the Panama Canal from ports on the north Pacific Coast to ports on the Atlantic can earn more money elsewhere.

There is no longer any need of railway transcontinental rates to Pacific Coast points being less than rates to intermediate distances on account of water competition.

It is probable that this condition will continue for a considerable time. The tonnage of merchant shipping on the ocean, through the combined effect of natural losses and destruction due to war conditions is being reduced faster than it is being restored by the building of new vessels.

One of the industries most seriously affected by these abnormal conditions is the lumber trade of the north Pacific Coast, which is dependent on low transportation rates to reach the markets on the Atlantic. In an address before the Seattle Engineers Club on Apr. 20 Kenneth C. Kerr, editor of the *Railway and Marine News*, stated that some 20 wooden sailing vessels are now being built on Puget Sound from native lumber and are to be equipped with Diesel oil engines for auxiliary power. These vessels are built to carry lumber from the coast mills to remote markets. It was generally supposed a half-dozen years ago that wooden vessels and sails for ship propulsion on the ocean were both obsolete. With steel at present high prices and unobtainable for hull, engine and boiler construction except after long delays, the wooden sailing vessel is a most useful resource.

Handling High-Class Freight Traffic on Inland Rivers

The question whether water transportation can be revived on the inland rivers of the United States is one of great interest to the public and to the engineering profession. It is well known that commerce has practically deserted most of the inland waterway routes of this country. There are numerous causes for this, but the great and controlling cause is the development of the railway as a freight carrier.

To look back for a moment to the history of transportation development in the United States, the facts that the steamboat was invented nearly a generation earlier than the railway locomotive and that water routes had always been the natural avenues for commerce were responsible for the early development of steamboat transportation throughout all the settled area of the United States in advance of the construction of railway lines. Further than this, it was not until the railways had been in operation for half a century that the cost of railway transportation was brought down to a point where the railway could begin to become a serious competitor of the steamboat in freight haulage. In the last forty years the railway has been marvelously increasing its efficiency as a carrier, while inland water-transportation methods and machinery have been practically stationary. The result is that there are very few inland waterway routes which are today carrying sufficient commerce to justify the investment which the Federal Government has made in their improvement.

Can commerce be restored to these waterways? Certainly not by pursuing the methods of the past. It hardly needs demonstration that, while the old-time river steamboat could compete with the railway as it was in 1850, it is hopelessly outclassed by the railway as it exists today. Those who believe in the possibilities of restoring water traffic, therefore, have long been on the lookout for some new methods and apparatus for water transport to meet the needs of the present day.

On Apr. 15 a new type of freight carrier began running on the Mississippi River between St. Louis and New

Orleans, and a detailed description of the vessel appears elsewhere in this issue. Even more important than the boat itself are the business organization and system of which the boat is a part. First and foremost, the new enterprise is organized and directed by an engineer, J. H. Bernhard, who has applied engineering methods to the work on which he has been engaged for several years past—the revival of river transportation.

It is pretty well known that such traffic as still remains on inland waterways is chiefly bulk freight of the lowest value. Even when the commercial tonnage on a river makes a respectable showing in the statistics, investigation usually shows that most of the tonnage is made up of sand, gravel, stone, logs, lumber and coal. Most of the freight on the Ohio River, for example, which has been made much of by the defenders of water transportation, consists of coal loaded from mines on the Monongahela River into cheap barges and floated downstream, during a rise in the river, to a market in New Orleans. Such methods of transportation do indeed show a phenomenally low cost of transport per ton-mile, but they are applicable in so limited a way that they can have little effect in restoring inland waterways to a commanding position in handling internal commerce.

While the cost of hauling these low-value bulk freights in river barges is very low, the cost of handling them at terminals is apt to be heavy; and the railway with its hopper-bottom cars, which are able to carry a load without transfer from origin to destination, can often show economy over the water route if a transfer to rail or wagon haulage has to be made at one or both ends of the boat's trip.

For these and other reasons the new boat line that Mr. Bernhard has inaugurated on the Mississippi is designed to carry not the low-value bulk freights, but the highest class of merchandise freights. The rates on this class of freight are high enough so that the cost of transfer at one or both ends of the boat journey is a small percentage of the total rate compared with the cost of transferring bulk freight. The reasons why Mr. Bernhard's new boat has a good chance of succeeding in its competition for merchandise freight that the old-fashioned type of river vessel has lost to the railways are not because Mr. Bernhard's barge is of steel while the old boats are of wood, not because his barge is propelled by oil engines while the old-time boats are propelled by the ancient stern wheels and antediluvian steam machinery, but because Mr. Bernhard, through his boats and his organization, purposes to furnish to the shipper a *reliable* and prompt transportation service, involving a minimum of risk.

The first barge put in service will be followed by three others during the summer. The Inland Navigation Co., which has built and is to operate these barges, is capitalized at $9,000,000 and plans to have 36 barges of 1,600 to 5,000 tons' freight-carrying capacity in service by the spring of 1918. The company announces that it will carry freight on a through bill of lading to any point in the world, and except for less than carload shipments and where the point of origin of the freight is not on a switch track, the company will absorb the switching charges at the point of origin, loading and unloading and the switching charges at the point of destination. The company also plans to absorb the cartage charges to and from the docks or wharves to the shippers' plants or warehouses in the river cities at which its boats land. Eventually, the company proposes to carry freight, including all the foregoing terminal charges, at 25% less than the all-rail rates. At present, however, as its service is incomplete and the expense in establishing the business is large, it will carry freight at a rate equal to the rail rate minus 25% of the company's net receipts from the traffic. Whether the company can make a commercial success of this business remains of course to be demonstrated. There seems every reason to believe, however, that it can carry at a material advantage over the rail service any freight originating and ending in the river cities where it operates.

One thing which may be well emphasized in connection with this subject is that the problem of reviving transportation on inland waterways is not, as is commonly supposed and generally claimed by the waterways advocates, a matter of securing further stupendous appropriations from the Federal Government for river improvement.

The waterways are there; and the depth of water in them is sufficient. If water transportation is revived in the United States, it will be by building such types of vessels and such forms of apparatus for handling freight where the vessels make landing and by operating both facilities in such an economical and businesslike manner that traffic will resort to the waterways because of their economic advantage.

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A dozen years ago the late John A. Hill, at that time the publisher of the *American Machinist*, wrote for the advertising pages of that publication a series of essays on the ethics of good advertising. These essays contained so much sound sense and represented such advanced ideas in the ethical conduct of advertising—ideas which at that time were comparatively new, but since then have been, thanks largely to Mr. Hill's influence, widely adopted—that it has seemed to us worth while to reprint these articles in *Engineering News*. The first of these essays appears in this issue on the second advertising page, and the others will follow in succeeding issues.

The essays are modeled after the well-known "Letters of a Self-Made Merchant to His Son." The style in which they were written, with its short, crisp sentences, was characteristic of Mr. Hill. It need hardly be said in these columns that he thoroughly believed in and practiced himself the policy that he preached. The first essay, as will be seen, is chiefly devoted to the condemnation of the practice of knocking competitors in advertising. In his second essay, which will appear in our next issue, he condemns in the following terse sentences the practice of publishing puffs and trade write-ups, so called, in technical journals:

> Keep out of papers that are free with the puffs. They will give a hundred-dollar puff to your competitor whom they hope to get as an advertiser and nullify the sixty-dollar ad you are paying for.
>
> A paper that spends time and money to interest its readers and is very, very chary about using any puffs or write-ups, for you or any other advertiser, is a paper to tie to.
>
> Even if it has the reputation of being mean about notices, stick, and put in your best puff in your regular advertising space. That's the paper that is read, and read by people who know an advertisement in disguise as well as they do a technical article.

Letters to the Editor

Beams Without Lateral Support; Relations of Formulas

Sir—The writer read with interest in the Apr. 6 number of *Engineering News* the article discussing beams without lateral support. Mr. Fleming has made a very comprehensive review of the formulas in present use. It is a matter, however, like that of columns in general, which with the knowledge of the subject at present and the lack of data compiled from a complete and systematic series of tests does not lend itself to a solution which is entirely conclusive or satisfactory. It is a notable fact that the results of formulas and rules given by different authorities, when compared, are very divergent. This, from the nature of the problem, could naturally be expected.

A few months ago the writer made a little study of the subject in order to see what relation, if any, exists between formulas for lateral flexure of beams and formulas for columns. He cannot say that he has any definite conclusion on the subject to offer, but wishes to present at least a thought on the subject.

The American Railway Engineering Association's "General Specifications for Steel Railroad Bridges, 1910," gives the following formulas for unit stresses in columns and compression flanges of beams:

> Unit stress in axial compression on gross section of columns, $16{,}000 - 70\frac{l}{r}$, where l is the length of the member in inches and r is the least radius of gyration in inches.
>
> The maximum unit stress in the compression flange of any beam or girder should not exceed $16{,}000 - 200\frac{l}{b}$ when flange consists of angles only or if cover consists of flat plates. Here l is the unsupported length of flange and b is the width of flange, l and b taken in the same unit of length.

Other specifications giving the same value for the unit stress in columns as the specifications just quoted do not give formulas for the reduction of unit stresses in compression flanges of beams and girders. Instead, they state that the unsupported length of a compression flange should not exceed 12 times the width of the flange. In other words, the unit stress in a flange whose unsupported length is 12 or less times its width need not be reduced for lateral flexure. Practically all specifications and ordinary practice make the gross areas of the tension and compression flanges on girders equal.

We will now attempt to find what relation exists between the column formula $\left(16{,}000 - 70\frac{l}{r}\right)$, the formula for compression flanges of beams $\left(16{,}000 - 200\frac{l}{b}\right)$ and the specification which does not require any reduction in compression flanges of beams where the unsupported length laterally does not exceed 12 times the flange width.

The maximum flexural stress, due to column action, developed in the flange of a beam that is unsupported laterally and carrying a uniformly distributed load is produced in a column whose length is approximately two-thirds the length of the beam. The derivation of the value for this equivalent column length by use of Ritter's formula for columns is given by Mr. Hess, as referred to in Mr. Fleming's article. Mr. Hess gives the equivalent column length for a uniformly loaded beam unsupported laterally as seven-tenths the length of the beam. Mr. Fleming states that Professor Moore gives the value two-thirds for the same case. Then l, the equivalent column length, would have a value only about two-thirds as great as l in the formula $16{,}000 - 70\frac{l}{r}$. The value of the radius of gyration in terms of the width of flange varies from $0.22b$ for flanges without cover plates to $0.24b$ for flanges composed of angles and cover plates. Using an average value of $r = 0.23b$ and substituting $\frac{2}{3}l$ for l in the formula $S = 16{,}000 - 70\frac{l}{r}$, we get

$$S = 16{,}000 - 203\frac{l}{b}$$

or, using round numbers

$$S = 16{,}000 - 200\frac{l}{b}$$

the formula for compression flanges of beams.

If, as usually specified, the gross areas of the tension and compression flanges of a girder are equal, the net area of the tension flange for girders with cover plates is approximately 85% of its gross area, for rivet spacing ordinarily used in the greater part of the girder length, and in its middle portion. It then follows that the unit stress due to bending (neglecting lateral flexture) in the compression flange will have an intensity only 85% as great as that in the net section of the tension flange. This difference in the unit stresses for the two flanges will be available for taking care of the lateral flexure. If the bending stress in the net section of the tension flange is 16,000 lb. per sq.in., then the stress in the compression flange (neglecting stresses due to lateral flexture) will be $\frac{85}{100} \times 16{,}000 = 13{,}600$ lb. per sq.in. Then if the maximum unit stress in the compression flange, including lateral flexure, is not to exceed 16,000 lb., the allowance for flexure equals $16{,}000 - 13{,}600 = 2{,}400$ lb. per sq.in. But this flexural allowance of 2,400 is represented in the formula $16{,}000 - 200\frac{l}{b}$ by the last term. And if $200\frac{l}{b} = 2{,}400$, then $\frac{l}{b} = 12$.

In designing and using the formula $16{,}000 - 200\frac{l}{b}$ for compression flanges, if the unsupported length is made equal to or less than $12b$, no additional section need ordinarily be added to the compression flange. This is due to the fact that the difference in area between the

gross section of the compression flange and the net section of tension flange will be sufficient to compensate for the stress produced by lateral flexure, the magnitude of which is calculated by the previously mentioned formula. Naturally, the case where a horizontal thrust is carried by the girder flange is excluded from the above discussion.

HENRY KERCHER.

Cleveland, Ohio, Apr. 18, 1916.

Flood-Prevention Plans in Los Angeles County, Calif.

Sir—As described in your issue of Feb. 17, 1916, check or restraining dams have been recommended for experimental testing in the report of the Los Angeles County Board of Flood Control and to a limited preliminary extent have been tried out in Haines Cañon, which drains 3.9 sq.mi. of the western face of the Sierra Madre range in this county.

The flood problems of southern California are difficult and unusual, the most severe feature being the enormous quantities of débris eroded from the steep mountains. It must necessarily be deposited in the flood channels crossing the plains, which have flat gradients. In Switzerland and Germany check dams occasionally are used primarily, if not solely, for the purpose of preventing erosion rather than for the control of the volume of flood flow. The Board of Flood Control, of which the writer was a member, recommended to the Board of Supervisors of Los Angeles County that substantial appropriations be made for continuing experiments with these dams, to determine their merit either in the control of erosion or in the preventing of the synchronism of the flood waves from various parts of the same basin. Provided these experimental construction works are accompanied with careful observations of stream flow, suspended matter in floods, rainfall, etc., not only in the basins that are so protected, but also in adjoining areas of similar topographic features and exposure, the work will be well worth while.

The people of our western country are so progressive that they are prone to seize upon slender hopes and develop them beyond proper proportion. For instance, it has been claimed by some that the floods in the lowlands can be prevented by spreading the water on the broad gravel cones where the streams emerge from their mountain cañons, thus putting the water underground by percolation. This would be a consummation devoutly to be wished. Near Riverside, it has been found that, for 14c. an acre-foot underground waters can be stored which subsequently are worth from $6 to $10 an acre-foot. This is a good investment.

The flows handled in this way are either small floods or the ordinary discharge during periods of nonuse of the stream. The crest of a large flood wave cannot be so used, first, because of its violence and, second, because the muddy water will clog the absorbent gravels in the spreading grounds. The crest of the great flood of the San Luis Rey River in San Diego County emerged from its cañon with a depth of over 15 ft. and a mean velocity from the mountains to the sea of nearly 20 ft. per sec. The job of spreading waters in that mood would be rather hazardous.

It has also been claimed that by planting forests in the mountains floods can be prevented. The trees and brush are desirable, and forestry is properly advocated and sustained. Forests retard erosion. The basin that has a forest cover will have a better summer flow therefrom; but after the forest floor has been saturated through a period of rain, the culminating great precipitation which produces the flood from other drainage basins will also produce one of practically equal volume from the forested area.

There is danger of this same optimism now being applied to the arguments in favor of check dams, as described in your issue of Feb. 17. They probably will do good in preventing erosion on the mountain sides and in cañons. They may even prevent the synchronism of floods from different portions of a drainage basin, although this involves a delicate computation of velocities. No generalized statement can be made about this. Each locality must be studied and may or may not be benefited by treatment in this regard.

If a great flood is projected naturally and uniformly down its mountain cañon at the rate of 12 mi. per hr. and if by the construction of many of these proposed check or restraining dams on the upper or outer perimeter of the drainage basin the flow from that section may be stepped down to half that velocity, there are localities where this would result not in a reduction of the total volume of the flood discharge in acre-feet, but in a substantial reduction of the crest of the wave in cubic feet per second as it rises from its cañon mouth. This would be a substantial accomplishment. The possibility of its demonstration was the justification for the Board of Flood Control for Los Angeles County recommending an outlay of $500,000 to test it thoroughly.

However, I, for one, do not believe that these small check dams will "store" water either directly or indirectly underground to any such extent as to affect the volume of the total flood discharge or so as to obviate the necessity of levees across the lowlands. Unfortunately, many laymen are assuming this conclusion, and this is apt to delay and interfere with flood control rather than benefit it.

The idea has been seized upon as an easy way to prevent damages that are serious and destructive. I know of no river the flood from which has been controlled in any other manner than by levees, except that in some instances valuable regulation has been obtained by the use of large storage reservoirs, as at the Roosevelt reservoir on Salt River, Arizona.

Personally, I am in favor of giving these check dams a thorough test and have used my best efforts in arranging with the scientific departments of the Federal Government for careful observations and inspection of the localities where they are being tried experimentally. Unfortunately, up to date, with the exception of determinations of rainfall in a few localities in Los Angeles County, there has been no adequate measurement made of the effect of these check dams in restraining floods or débris in the places where they have been tried as compared to other adjoining localities where they have not. As far as I know, there is as yet nothing upon which one can base a fair judgment or conclusion as to their value in this region.

Forestation, spreading of storm waters on débris cones, the construction of surface storage reservoirs and the building of the small check dams in the higher portions of the mountains—all must be adopted in the conflict with the flood, on the one hand, and in preserving the

summer flow, on the other. Every resource and energy must be utilized to make successful issue in this conflict with the torrents. Even then the remaining problem is most grave and severe, calling for all the reserve of skill that is available.

J. B. LIPPINCOTT.
1100 Central Building, Los Angeles, Calif.

Coefficients of Retardation in Kutter's Formula

Sir—In Mr. Horton's article in your issue of Feb. 24, suggesting coefficients of retardation in Kutter's formula, I noticed that values for use in the design of pipes are included. Any of the numerous exponential formulas when compared with the Kutter formula show that the value of n varies with the size of the pipe and, in a given size of pipe, with the velocity. Therefore, it is impossible to assign correct values of n for definite conditions of pipe (perfect, good, fair, bad) and ignore size and velocity. Kutter's formula was designed for use on open channels, being based wholly on tests made on open channels, and does not apply to flow in pipes under pressure, as is shown by the fact that it does not agree with an exponential formula derived from actual field tests of flow in pipes under pressure.

I am of the opinion that values of n lower than 0.012 found by tests on concrete linings are merely due to experimental errors to the extent of the variation from this figure. This opinion is based on the following evidence: The Ridenbaugh Canal, near Boise, Idaho, shows as nearly a perfect surface as can be imagined in a construction for commercial use. Experiments have been made on various reaches of this canal by a half-dozen different field parties. Don H. Bark found values ranging from 0.0095 (on a short reach 340 ft. long) to 0.0118 (on a reach 1,478 ft. long). W. G. Steward found values from 0.0112 to 0.0132. Eleven of his 13 tests show values above 0.012. B. P. Fleming found 0.0124 on a reach with one slight curve. The writer found 0.0121 on a tangent and 0.0129 on a reach containing both tangent and curves.

It should be borne in mind that this lining had cement mortar smoothed over the concrete with a steel trowel. No roughness appears at the expansion joints. The whole surface is practically one smooth unbroken sheet, as shown by Fig. 1.

FIG. 2. CANAL IN SOUTHERN CALIFORNIA, SHOWING MASS AND MINERAL DEPOSIT

This accumulates on smooth or rough concrete alike. Kutter's "n" is from 0.016 to 0.018 in these canals

Until the most recent years too low a value of n was used in the design of both concrete-lined channels and wooden flumes. The value of n recommended by Schuyler, Freeman and Stearns in 1907 for use in the design of open portions of the Los Angeles aqueduct in concrete linings would have been called absurd 20 years ago. This value (*Engineering News*, Vol. 57, p. 614) was 0.018.

Both J. B. Lippincott and the writer found numerous cases in southern California where the value of n in concrete linings exceeded 0.016, yet many textbooks still hold to values of 0.011 for "cement with one-third sand." This is the nearest thing to concrete mentioned and implies that no higher value of n should ever be used. As a matter of fact, it is doubtful if such a low value should ever be used.

The conditions that require using a value of n between 0.016 and 0.020 for concrete linings are, as a rule, not the fault of original poor construction. Moss and mineral growth and débris accumulations are generally responsible for such values, and these must be anticipated by the designer through his knowledge of the climate and waters (see Fig. 2). Rock ravelings are to be looked for wherever a lined canal is located on a hillside bench

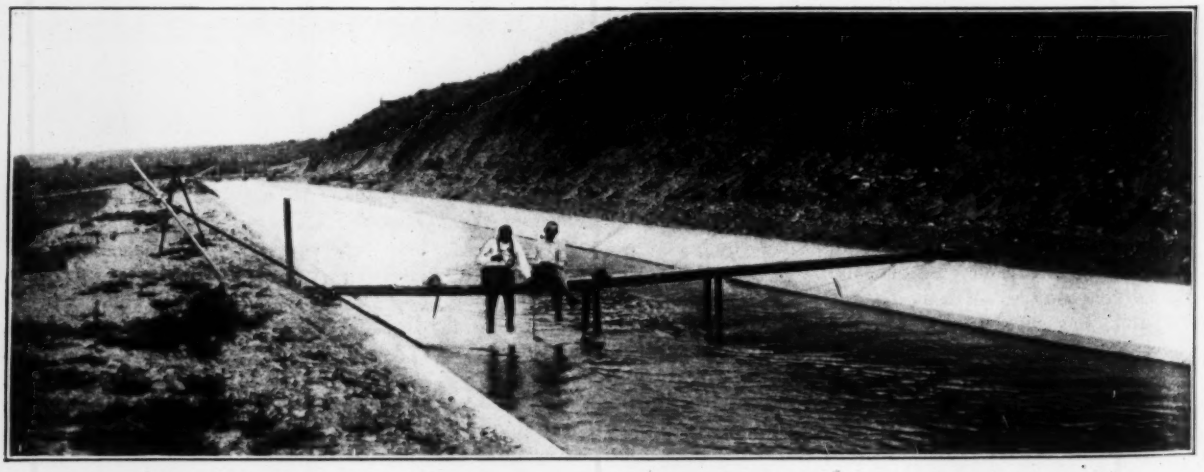


FIG. 1. THE CONCRETE-LINED RIDENBAUGH CANAL, NEAR BOISE, IDAHO

cut in rock, especially if no space is left between the upper canal wall and the side of the cut. Sand must be eliminated from the water, if the smoothness of the concrete or plank floor is to be relied upon for a high carrying capacity. There are many canals in southern California where the bottom is covered with sand to a depth of from 6 to 18 in. In such cases, of course, the lining merely prevents seepage losses and contributes nothing toward a high carrying capacity.

I would like to take this opportunity to correct the citations given by Mr. Horton at the end of his article. They should have read something like this:

Report of the Florida Everglades Commission; Bulletin No. 194, United States Department of Agriculture, "The Flow of Water in Irrigation Channels," by Fred. C. Scobey; Bulletin No. 194, Colorado Agricultural College Experiment Station. "Frictional Resistance in Artificial Waterways," by Cone, Trimble and Jones; and a staff article in "Engineering and Contracting," Jan. 27, 1915, taken from Bulletin 126, United States Department of Agriculture, "Concrete Lining as Applied to Irrigation Canals," by Samuel Fortier.

FRED. C. SCOBEY,
Office of Public Roads and Rural Engineering.
Washington, D. C., Feb. 28, 1916.

[Mr. Horton's comments on the foregoing letter follow.—Editor.]

Sir—The writer concurs in Mr. Scobey's opinion that values of n lower than 0.012 should not be used in designing concrete- or cement-lined channels. However, the writer's table was not intended merely to cover values to be used in designing, but also values to be used in the solution of other problems occurring in hydraulic practice. For example, where a diversion conduit has been built, it is sometimes necessary to estimate, in the absence of gagings, the maximum quantity of water which such a conduit will actually carry when new and in perfect condition. This question often arises in settlement of diversion damages. Under such circumstances it is desirable to have at hand the minimum values of the coefficient of roughness applicable to a perfect channel or conduit of the given type, although it would never be expedient to use the absolute minimum values in designing the conduit which it is desired shall assuredly convey a certain quantity of water. In general, in designing, the capacity should be such that the conduit will convey the required amount of water after it has been in use for a considerable period of time, and the joints and surfaces have become somewhat imperfect.

The writer's table was presented for the purpose of showing coefficients of roughness ordinarily applicable in the Kutter's formula in accordance (1) with the best accepted authorities and (2) with the latest experiments.

The writer did not attempt to present any argument as to whether or not the Kutter formula itself is the best one applicable to any set of conditions. It is a fact, however, that Kutter's formula is still very largely used in estimating the flow in pipes and conduits as well as canals and rivers; and while that condition remains, it is desirable that the best available coefficients of roughness for such conduits should be utilized.

Various exponential formulas for flow in pipes have been devised. In such formulas a constant coefficient, replacing the coefficient C in the Chezy formula, is commonly used. Theory indicates, and practice confirms the belief, that no formula can be devised involving only a single term or power of r and s in which the coefficient will be absolutely constant. While the use of exponential formulas eliminates the separate calculation of the coefficient C, yet it appears that the variation in the assumed constant coefficient C in such formulas actually is as great, or about as great, as the variation in the coefficient n for the same class of conduits. There is undoubtedly room for improvement in existing formulas for calculating flow both in pipes and in open channels. The laws of flow, where uniform or stream-line motion pertains, as below the critical velocity, are different from the laws of flow for sinuous motion at higher velocities. As long as single-term formulas are adhered to, it seems certain that difficulty will be experienced in devising any single formula for either pipes or channels which will give equally good results for both high and low velocities. Single-term formulas are, however, generally adhered to at the present time for two reasons: (1) Because they give greater simplicity of calculation than the two-term formula would give; (2) because there has accumulated a large body of data, especially with reference to the Kutter formula, which makes its application in many cases more certain than that of newer formulas, although this formula is less elegant from a theoretical viewpoint.

Attention should also be called to schedules Nos. 3 and 5 for "Natural Stream Channels." In some manner the coefficients for these two classifications became transposed. The correct values are as follows:

	Perfect	Good	Fair	Bad
(3) Winding, some pools and shoals, clean	0.033	0.035	0.040	0.045
(5) Same as 3, some weeds and stones	0.035	0.040	0.045	0.050

ROBERT E. HORTON.
Albany, N. Y., Mar. 18, 1916.

Engineers' Personal Interests Require Co-operation

Sir—In the Apr. 27 issue you published an editorial under the heading "Coöperate, but to What End?" This editorial is of a very unusual character, having in it a human interest that is in general altogether lacking in technical journals.

There are great pleasure and satisfaction in the work of an engineer. It is written in the Bible that man shall not live by bread alone. It seems today quite important for someone to emphasize that neither shall man live by work alone. The personal interests of engineers are in need of consideration. It is a matter of great importance that this thought has been borne in upon *Engineering News*.

The universally favorable comment upon the conference in Chicago and the extended space devoted thereto by technical journals bring home to the profession in a very emphatic form the personal need of the engineer.

It is clear that the writer of the editorial did not attend the conference, for he says "they went apart with no more definite purpose than to coöperate, somehow, in the future." No person present at the conference could fail to notice the intense interest in its proceedings by each of the men who were present, nor could he fail to observe that these men represented the best of the respective associations to which they belonged; and furthermore, he could not fail to note the decisive purpose pervading the remarks of all the speakers to achieve a betterment in conditions affecting the practice of engineering.

ALBERT J. HIMES.
Hickox Building, Cleveland, Ohio, Apr. 29, 1916.

Oil-Engine Driven Steel Barge for River Freight Traffic

A novel type of vessel for freight traffic on the Mississippi began running between St. Louis and New Orleans on Apr. 15 and has aroused great interest among those who look for a revival of traffic on the river.

The new vessel is the "Inco No. 1," built and owned by the Inland Transportation Co., of 52 Broadway, New York, and St. Louis. The President of the company and the moving spirit in developing this new craft and putting it in service is John H. Bernhard, Assoc. M. Am. Soc. C. E. Mr. Bernhard was also chiefly responsible for the design and construction of the steel barges, propelled by gas engines using gas from producers, which have been running for the past year between the Warrior River, in Alabama, and New Orleans. These barges are operated by the Alabama & New Orleans Transportation Co. and were described in *Engineering News* of Dec. 4, 1913.

In the new venture in Mississippi River traffic, however, Mr. Bernhard is aiming to carry not the cheapest

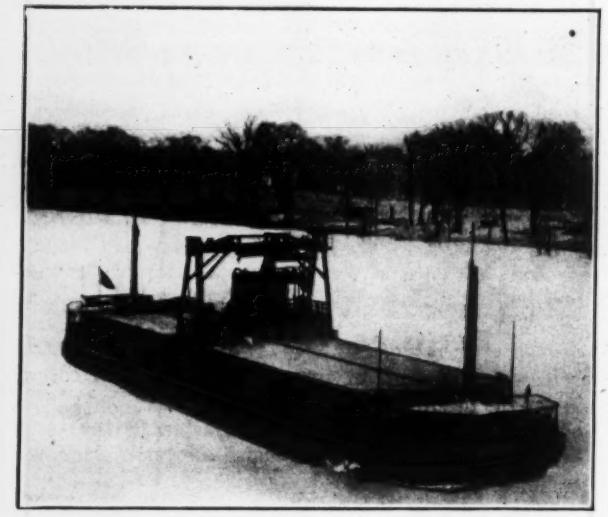


FIG. 1. STEEL BARGE PROPELLED BY OIL ENGINES FOR MISSISSIPPI RIVER TRAFFIC

class of bulk freight like coal, on which rates are very low, but high-class merchandise freight. The rail rate on this traffic is very much higher than on low-class bulk freight, and the boat line can make a strong appeal for such freight, not only on the ground of lower rates but of quicker delivery.

Of course, at times of car shortage like the present, shippers are eager to send goods by the boat line; but even under ordinary conditions the delays at railway terminals are such that a boat shipment from one city on the river to another will usually reach its destination in half or a third the time it would if sent by rail.

Merchandise shipments have been sent by rail instead of by boat, however, because the old river craft still in service are irregular and unreliable. Goods are roughly handled and poorly protected from the weather, from thieves and from fire, and in case of loss, recovery by the owners of the goods is more or less doubtful. All these conditions Mr. Bernhard hopes to change in his new type of boats, which are to run with regularity and are so designed as to reduce as much as possible the liability to accident and thus to popularize his service.

The new type of boat is a steel barge, with flat [illegible]. It is 240 ft. long, 43 ft. wide and with a draft of [illegible] ft. can carry 500 tons. At 7½-ft. draft it will carry [illegible] tons. The barge is covered with a steel-plate deck protected by a wooden floor. The cargo is carried on this deck, nothing whatever being carried in the [illegible] space between the barge's bottom and this deck. This space contains steel posts which support the deck beams and at the same time form the verticals for five lines of longitudinal trusses. These posts also support transverse water-tight bulkheads which divide the hull into five separate compartments.

The advantages of carrying the cargo on the deck instead of in the hold are the much greater convenience of loading and unloading and the lessened liability to damage in case of leaks. Further, the longitudinal trusses previously referred to and the transverse bulkheads give the hull a strength and stiffness far beyond that of ordinary river craft.

To protect the cargo from the weather, the cargo deck has permanent sides with ten openings on each side closed by rolling steel doors, and a roof that is made in sections so that any section can be lifted off when it is desired to handle the cargo from the top.

Probably the most striking feature of the boat in its external appearance is a traveling bridge crane which runs on rails that extend along each side of the deck outside the deckhouse. A telescoping boom on this crane may be extended out on either side of the boat to a distance of 68 ft. and will carry a load of 3 tons.

The old-time Mississippi river steamboat carries a long heavy gang-plank swung from a spar at its bow, and as there are few river towns along the Mississippi that have any wharves, this long gang-plank is necessary to reach from the steamer to the river bank where a landing is made. The traveling crane on the "Inco No. 1" takes the place of the gang-plank. It can hoist any section of the roof, lift the cargo from the section beneath and transport it to the shore. It can also be used instead of davits for lowering boats. For handling cargo on and off the boats an electric truck is carried on board and other trucks are to be available at the landings. Electric endless-belt conveyors are also to be used to transport freight on and off the boat.

The barge is propelled by four 80-hp. Fairbanks-Morse oil engines burning a petroleum distillate of 29° Baumé gravity. Each engine has four cylinders, operates on the four-stroke cycle and drives a screw propeller 51 in. in diameter. The propeller has four blades bolted on a central hub. There are trap-doors in the floor of the barge, over the propellers. Through these doors the propellers can be reached and a broken blade removed and replaced with a new one as quickly as one could change an automobile tire. In tests, blades have been changed in 9½ min.

The engine room is at the stern, and the cook's galley is at the bow. When the boat is running without load, the extra weight of the engines in the stern increases the draft aft and reduces the draft forward, so that the propeller immersion is about the same with the boat light and loaded.

The engines are started by compressed air stored in tanks at 150 lb. pressure. An electric generator driven by silent chain from one of the engines furnishes current for lighting the boat and also for operating a dozen or

electric motors used for various purposes on board. When the boat is stationary and it is desired to operate the generator to furnish current—for handling cargo, for example—a clutch on the propellor shaft is opened and the engine runs without driving the propeller. Electric current is used for all heating and cooking, and no fire whatever is allowed on board.

The barge is further equipped with three powerful searchlights—one at the bow, one at the pilot house and one at the stern; each of them can be operated from the pilot house. The combined power is 18,000 cp.

The boat has four balanced rudders aft of the propellers. In maneuvering, one side engine can run ahead while the one on the opposite side is backing. Further, to assist in swinging the bow, as in coming alongside or leaving a pier, there is an electric motor-driven rotary pump at the bow under control of the pilot, which can draw water from either side and deliver an 8-in. stream on the side opposite; the reaction of this jet exerts a strong force against the bow.

The boat is operated by a captain, mate, two engineers, two oilers, four deck-hands, cook, helper and two wireless operators, who act also as freight clerks—a total of 14 for a double watch. Instead of carrying its own gang of roustabouts for cargo handling, reliance is placed on the freight-handling force at the wharves where the boat will land.

There is a refrigeration plant on board capable of cooling a chamber of 6,000 cu.ft. capacity to a temperature of 31° when the temperature outside is 95°. The refrigeration plant is designed not merely to maintain a low temperature in the storeroom adjacent to the cook's galley, but enables the boat to handle butter, eggs and similar freight which requires refrigeration.

Appliances for protecting the boat against accident are especially complete. As already explained, the 6-ft. high space between the deck and the bottom of the barge is divided into four water-tight compartments which can also be made airtight, so that water could not enter the hull faster than it could force out the air contained, and by the provision of a small air compressor on board it would be easy to expel water if it gained an entrance. There are also connected with the water-tight compartments three powerful electric bilge pumps which may be put in operation by a switch in the pilot house and which are capable of discharging 8,000 gal. per min. Mississippi River boats frequently get out of the channel and run aground. The "Inco No. 1" carries 2,000-lb. anchors at bow and stern, and by the aid of powerful electric winches these can be made use of to haul the boat off if she runs aground. Another most unusual device for a Mississippi River boat is a gun similar to those used in the life-saving service for sending a line on board a wrecked vessel. The gun can shoot a line 1,750 ft. The barge carries two boats—a 20-ft. power launch capable of 22-mi. speed, which can be put into the water by the traveling crane in two minutes; also an ordinary rowboat. In the swift currents of the Mississippi it is often a difficult matter to carry a heavy line to shore for use in hauling the boat off a bar. With the life-saving gun, however, a line can be shot to shore and a boat's crew sent ashore to haul it in and draw a cable after it.

At each end of the barge is a telescopic wireless mast which can be quickly lowered when passing under bridges. The barge carries two wireless operators, so that it can be communicated with at any time from the offices in

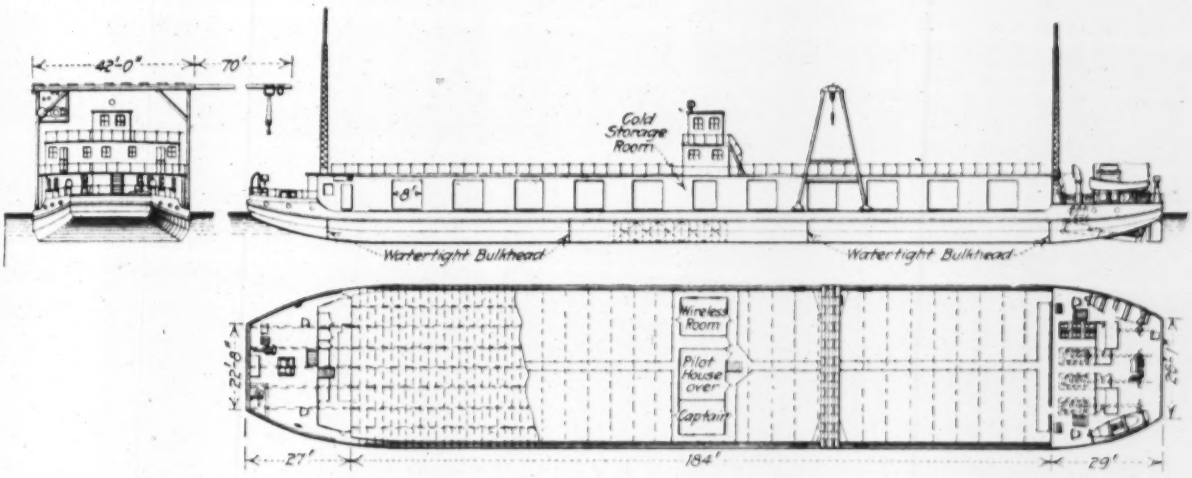


FIG. 2. PLAN, SIDE AND END ELEVATION OF STEEL BARGE "INCO NO. 1" FOR MISSISSIPPI RIVER TRAFFIC

St. Louis and New Orleans. The captain regularly reports to these offices his position, speed, the weather, etc., and can promptly summon help in case of need. In addition, the accounting department is informed of the freight on board the boat before its arrival, and the time of arrival can be so closely gaged that a force of roustabouts to handle the freight can be on hand as soon as the boat arrives, without wasting time waiting for it.

The "Inco No. 1" surpassed the expectations of its designers in the speed which it made on its initial trip from St. Louis to New Orleans. The river was in flood and the boat had the aid of the current, but an average speed of 16 mi. per hr. was attained.

Three additional barges are under construction and will be placed in service this summer. The company plans to have 36 barges in service by the spring of 1918.

Raising a Town above its natural elevation is the method to be adopted at Milan, Ill., for avoiding flood troubles. For years there has been periodical flooding from the Rock River, causing property damage and unsanitary conditions. The present plan is to elevate the grade from 2 to 6 ft., raising the buildings and filling in all old cellars and basements to a corresponding amount.

Land-Drainage Project in Northern Minnesota

The reclamation of a large area of swamp land in northern Minnesota is to be effected by the construction of a system of 223 mi. of drainage ditches, known officially as "judicial ditch No. 25." This work will include also bridges, culverts and roads and a 17-mi. river-channel revision. The total cost will be over $500,000.

This drainage system, shown on the accompanying plan, will drain the basin of the headwaters of the Rapid River, an area of about 195 sq.mi. Practically all of this is Government land and is settled along the river, where natural drainage permits immediate development. The wet condition of this land is not due to lack of fall, but to the character of the soil, which is peat and muck, with sand ridges that impede natural drainage. The work will cost about $4 per acre. It is provided for by a bond issue and assessed according to benefits.

The regularity of the topography makes possible the location of ditches along the section lines, with an 18-ft. roadway on the spoil bank on the lower side of the ditch. There will be also a revision of the river, reducing 24 mi. of channel to a length of 17 mi., besides deepening and enlarging it to give adequate capacity for the discharge of laterals and the reclamation of rich bottom lands now subject to annual overflow.

Lateral and Cross-Drainage Ditches

The general plan of drainage consists of laterals 1 mi. apart, connected by cross-ditches at 2-mi. intervals. In the northern part of the area the laterals will run east to the river; in the southern portion they will run to the eastern boundary, where the water will be diverted to the north and discharged into a much more defined valley than that offered by the headwaters. As ample depth in the ditches is required to secure extensive lateral effect as well as to provide road material, this arrangement will relieve the river and consequently lighten the improvements necessary there.

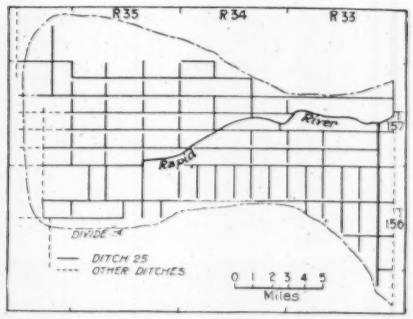
The liberal use of cross-ditches is required primarily for effective drainage, but it adds also to the efficiency of the road system. For the numerous ditch crossings thus required, pile bridges have been specified, with a view to the use of dredges in cleaning and the facility of placing permanent structures at a later period.

The average depth is about 7 ft. for lateral ditches and 6 ft. for cross-ditches. The base width is generally 4 ft., a 3-ft. width being specified only sparingly and in connection with grades sufficient to furnish a cleaning velocity. Frequent use is made of larger bases, particularly on the river, where the width ranges from 12 to 35 ft. The average excavation is about 14,000 cu.yd. per mi. The average depth of the topsoil is 4.5 ft., ranging from a few inches to 14 ft.

As no rainfall records or runoff measurements have been made within this territory, it has been necessary to use the data of neighboring stations. The assumptions are that an area of 10 sq.mi. should have a drainage outlet of capacity to remove $\frac{3}{8}$ in. of water in 24 hr.; while for an area of 200 sq.mi. the outlet capacity should be $\frac{3}{16}$ in. in 24 hr. In the design of ditches Kutter's formula has been employed with n equal to 0.025, while a value of 0.030 n has been used on the river-improvement design. However, in many cases conditions nullified the use of the formula, as where hydraulic efficiency is sacrificed for the more desirable elements of ample depth, road material and the added effect of drainage through the subsoil.

On account of the impassability of the country during the open season and the annoyance of great swarms of mosquitoes, surveys for this work must be made during the winter. A tent outfit is carried because of the sparse settlement and extended areas. The methods of preliminary survey were similar to those in general use throughout this section. Compass lines are started from the section corners and picketed through by axemen to the quarter-post, where a new line is started. Tapemen set station stakes, and levels are run, sea-level datum being used.

Soundings of the topsoil are made every 300 ft. along the lines, and the depth and character of the topsoil and subsoil are recorded. Notes of the timber (size, kind, cost of clearing and availability for construction purposes) are made at intervals frequent enough to include any appreciable changes. Every corner is referred to trees sufficiently far removed to escape cutting in the 66-ft. right-of-way. The present wood posts at corners will be replaced during construction by concrete monuments. Bench marks were placed every half-mile.



PLAN OF DRAINAGE DITCHES IN THE RAPID RIVER VALLEY, MINNESOTA

Drainage-Survey Methods; Winter Work

An efficient method of operation worked out during the prosecution of this survey eliminated all waiting of one party on another. Axemen in pairs, using pocket-compasses to start them from the section corners, cut line in different localities fast enough to keep the untaped line well ahead of two tapemen, who were occasionally assisted in keeping ahead of the level by two axemen.

The entire party was thus separated into pairs, each of which was always "behind," save the axemen; and a natural rivalry among them to bring in the most line kept the work at top speed. Chainage was started from each section corner, permitting the chainmen to work on any line cut for them. Construction chainage must be run to place stakes corresponding to the chainage of the profiles.

The inconvenience of individual lunches, since no two pairs worked together, was overcome by the adoption of the "nose-bag" method of log drivers, each man selecting his own lunch after breakfast and packing it within his own coffee can, tying the whole in a small bag fitted with cords and wearing it on his back. The annoyance of the bag is negligible. The result of all hands working under pressure is an appreciable increase in the output of line.

The cost of surveys of this character has ranged from $16 to $20 per mile, varying with the growth of timber, accessibility of the region and like factors.

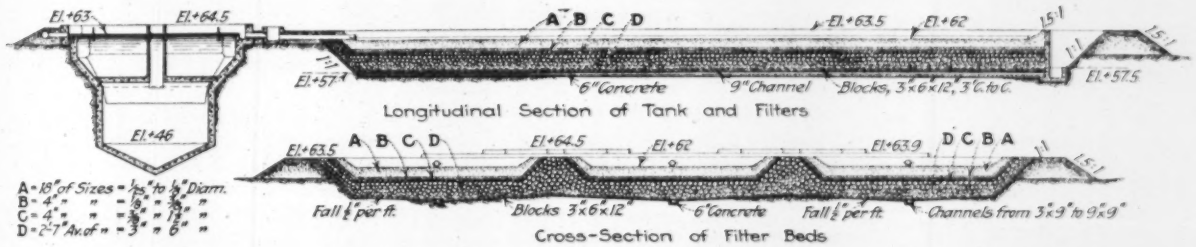
The soil soundings of the survey indicate that 5% of the topsoil is sandy loam, 10% is black and sandy loam of the river valley and banks, 55% is black muck and peat 1 to 5 ft. deep, and 30% is similar material 5 to 14 ft. deep. The subsoil is a glacial deposit of sand and clay.

The project has been divided into five divisions, so as to place the work within reach of the smaller contractors. Three of these divisions are best suited for floating dredges—namely, the river division of 23 mi. and two divisions of 37 and 40 mi. located in the areas of deep muskeg. Two sections, of 62 and 78 mi., can be handled by dry-land machines. Contracts will be let May 19 at Bemidji, Minn. The total cost, exclusive of roads, is estimated at $406,770.

The referee in ditch matters is O. L. Dent. For judicial ditch No. 25, A. A. Andrews is attorney, and John C. Burke, of Bemidji, Minn., is Engineer in Charge.

Imhoff Tank and Dunbar Filters at Ennis, Tex.

Dunbar filters to treat the effluent from an Imhoff tank are the unusual feature, for the United States, of a small sewage-disposal plant with a daily capacity of 200,000 gal., designed for Ennis, Tex., by N. Werenskiold, consulting engineer, Dallas, Tex. There will be two Imhoff tanks, a sludge-drying bed and three Dunbar filters.



SECTIONS OF DUNBAR SEWAGE FILTERS, ENNIS, TEX.

The accompanying sections through the bed show the size, depth and arrangement of filtering material. It will be noticed that the different layers of material are carried up the slopes. The filtering material is further described in the specifications, as follows:

> The filter material must be of a durable class and free from dirt; it may be from good cinders, slag, coke, hard-burned brickbats, clinkers or a hard and durable rock or gravel and of sizes shown on plans. The bottom layer D may be separated from the mass by forking; the finer material in the supporting layers C and B, as also in the distributing layer A, by screening through suitable screens. To prevent early clogging, the upper layer A should preferably be of cinders or coke; but if these materials are not available, sand, screened from gravel, will answer the purpose, though cost of maintenance and cleaning will be greater. The lower layer should be placed as loosely and with as many voids as possible, in order to provide good ventilation, the principal purification taking place in this layer as the sewage trickles through it.

The Imhoff tanks are designed for a sewage flowing-through period of 2 hr., based on an assumed hourly flow of one-sixteenth the daily flow. The sludge-digestion chambers have an available space of 1.1 cu.ft. per capita, or both tanks are equivalent to 3,300 cu.ft. for 3,000 people. The filter beds have an available area of 2,400 sq.ft. each, or 7,200 sq.ft. for the three beds.

Mr. Werenskiold says that he has used a Dunbar filter at Weatherford, Tex., in connection with an old septic tank and that the filter has given good results for the period of a year and a half during which it has been in operation, the effluent being clear, odorless and stable.

Another Dunbar bed installed by Mr. Werenskiold as engineer is located on the grounds of the golf and country club near Dallas, not far from houses and right within the grounds. The effluent is discharged in a ravine that crosses the public highway just below the plant. Mr. Werenskiold understands that the results given by this bed have been satisfactory during the year it has been in use.

In general the only difficulty experienced in these beds, Mr. Werenskiold says, is the tendency for the upper layer to choke, if of sand. On that account he is going to use a dosing tank for a small plant now being built, where nothing but sand is available. In commenting further on Dunbar filters Mr. Werenskiold says:

> The great advantages of these filters are that they are so very elastic. They will give good results for new plants, where the discharge gradually increases from nothing to a considerable amount in the course of a few years. They require comparatively little attention. The sewage can be turned on the bed to run for a week or two, till a film is formed and it fails to discharge the amount, then it is shifted on another bed, the first one rested, the film removed and surface raked up, if needed. Sprinkling filters seem unsuitable for small plants, and contact beds give none too good results.

Bids for the construction of the sewage works were received on Feb. 26 and ranged from $9,500 to $15,000. About Apr. 1 it was reported that the bids had been rejected and that the city would raise funds for sewer construction on the revenue to be derived from the sewers.

Ice Every Month in the Year was the record a century ago, according to extracts to notes sent to "Engineering News" by Carl P. Birkinbine, Parkway Building, Philadelphia. These notes are in the form of monthly summaries of weather conditions for the year 1816, extracted from a book published in 1847 by Charles Pierce, entitled "A Metereological Account of the Weather in Philadelphia from Jan. 1, 1790, to Jan. 1, 1847." The early months of the year were warmer than the average, but according to Mr. Pierce's detailed note there was ice ½ in. thick several nights in April and from ¼ to ½ in. thick "in exposed situations" some mornings in May. For June "there was said to be ice" one morning. In July, according to the record: "One frosty night was succeeded by another, and thin ice formed in many exposed situations in the country. On the morning of the 5th there was ice as thick as window glass in Pennsylvania, New York and through New England." Ice was also reported in August, September and October. For the entire year the "medium temperature" in Philadelphia "was only 49." Moreover, "it was the coldest summer ever known in the West Indies and in Africa," and it was also very cold in England.

News of the Engineering World

Bone Patent Case Dismissed

The case of Frank A. Bone against the Walsh Construction Co. for infringement of United States Patent No. 705,732 on a reinforced-concrete cantilever retaining wall was dismissed by Judge Wade of the United States District Court, at Davenport, Iowa, on Apr. 24. This date had been assigned for the trial last October, but when the case was called, counsel for the plaintiff filed a motion for continuance, basing the motion on the ground that his expert witness was otherwise engaged. He did not state who this witness was or what the general nature of his testimony would be. Inasmuch as notification of trial had been ample and the defendant was prepared, the judge overruled the motion and ordered the case to proceed to trial. Plaintiff then dismissed the case without prejudice, and was ordered to pay costs.

Rapid Transit for Cincinnati

By a vote of 39,726 for to 6,652 against, the City of Cincinnati, Ohio, on Apr. 25 approved the issuance of $6,000,000 bonds for the new rapid-transit scheme described in *Engineering News*, Apr. 6, 1916, p. 673. The main feature of the plan is a high-speed belt railway through the business district and following the line of an existing canal, which it is proposed to abandon. Part of the road will be in subway and part in open cut. Work will be started soon under the direction of F. S. Krug, Chief Engineer, Board of Rapid Transit Commissioners.

Cleveland Engineering Forces Are Reorganized

Although retaining Robert Hoffmann as Chief Engineer of the Department of Public Service of Cleveland, Ohio, somewhat extensive changes have been made by Director Alexander Beinstein in going down the scale. J. M. Estep, formerly Assistant Chief Engineer, has been dropped and his office abolished. The same is true of the position of Engineer-in-Charge of Rivers and Harbors, held by Edgar B. Thomas. Mr. Thomas was offered a position in the Sewer Department, but declined. The work in connection with rivers and harbors has been turned over to F. D. Richards, Bridge Engineer, who will rank next to the Chief Engineer. The position of Superintendent of Bridges, formerly held by John Dooley, has been dropped, and the work pertaining thereto given to G. E. Randall, Assistant Bridge Engineer. The Sewer Department has been put in charge of A. L. Stevens, who formerly was in charge of sewer construction; and G. A. Korell, formerly Assistant Engineer in Sewer Design, has been promoted to the position of Assistant Engineer in Charge of Sewer Design. The positions of Superintendent of Sewers and Foreman of Repairs have been abolished and the work will be put in charge of one engineer yet to be appointed.

Design for Road Signs Wanted

Designs for a guide to be used exclusively upon the state-aid roads of Illinois are invited by the State Highway Commission and must be submitted to the Commission, at Springfield, Ill., on or before June 1. The award will be made by July 1, and a prize of $25 paid to the person whose design is accepted.

It is specified that the sign must be simple, distinct, exclusive in design, not over 7 ft. high (when erected), and costing not over $25 complete, ready for erecting. It must be of metal or concrete and provide space for placing characters, letters and figures for giving the direction and distance to objective points. The design selected is to become the property of the Commission. Other designs submitted will be returned if requested. William W. Marr is Chief State Highway Engineer, at Springfield, Ill.

American $5,500,000 Contract for Work in Uruguay

One of the largest contracts ever placed with an American firm for work in South America is that for the construction of water-works and sewerage systems for the three cities of Salto, Paysandu and Mercedes, in Uruguay, which has been taken by the Ulen Contracting Co., of Chicago. The total cost will be $5,534,000, and it is expected to have the work completed in two years.

The cities of Paysandu (21,000 population) and Salto (22,000) are on the Uruguay River and respectively 70 and 112 mi. above Treyventos, which is the farthest river port reached by ocean steamers. The City of Mercedes (16,000) is 30 mi. up the Rio Negro. Materials are shipped directly from this country to Treyventos and thence transported by lighters and tugboats.

The water-supply is taken from the river in each case and pumped to settling basins, as the water contains considerable silt. The water is of good quality. It will be passed through sand filters and then forced by high-pressure pumps to the storage reservoir or tanks. At Paysandu and Salto each town will have two elevated steel tanks of 1,000 cu.m. capacity, while at Mercedes there will be a clear-water distributing reservoir of 200 cu.m. capacity. The distribution systems for the three towns will comprise about 1,000 mi. of 4- to 24-in. cast-iron pipe, or about 14,000 tons of pipe and special castings.

The sewerage systems will be on the combined plan, for both storm water and domestic sewage. There will be about 86 mi. of 8- to 22-in. concrete pipe, made in lengths of 39⅜ in., also 15 mi. of monolithic sewers from 24-in. diameter to 6.4x7.5-ft. egg-shape section. The sewage will be delivered to purification plants, including septic tanks and sand filters. The effluent in each case will be discharged into the rivers. The cement used is a local product, known as the Metzen portland cement.

which is manufactured at Montevideo. About 15,000 metric tons will be required.

The excavation is being done by two Marion steam shovels and two Buckeye trenching machines. The steam shovels have extension dipper handles for work on deep trenches and are equipped to operate also drag-line and clamshell buckets. For the concrete pipe plant there are two Blystone concrete mixers and a McCracken pipe-making machine. For the monolithic concrete sewer work there are four Marsh-Capron concrete mixers, from which the concrete is raised by Lakewood elevators and towers and spouted directly to the forms. Steel forms of the Hydraulic Pressed Steel Co.'s make are used. The 14,000 tons of cast-iron pipe and specials is furnished by the United States Cast Iron Pipe and Foundry Co. and the American Cast Iron Pipe Co.

The original plans for these works were prepared by a French firm, but have been revised by the engineering staff of the contracting company. The Stone & Webster Engineering Co., of Boston, acts as consulting engineer. Work was commenced on Apr. 1, and a large amount of machinery and material is now on the way.

Henry C. Ulen is President of the Ulen Contracting Co., First National Bank Building, Chicago. John R. Ulen is Vice-President, and C. M. Bonnell is manager of the company's bond department, which handles the financing of the contract. M. R. Keefe is Chief Engineer. The branch office at Montevideo is in charge of Earl C. Ulen, Vice-President, and Thomas Shepperd, General Manager; E. G. Trueheart is Chief Resident Engineer, and H. W. Hengst is General Superintendent of Construction. The company has sent down about 24 engineers, superintendents and foremen, and about 500 to 600 men will be employed when the works are in full progress.

Wood-Preserving Statistics

Statistics of the wood-preserving industry, collected by the American Wood-Preserving Association and the Government Forest Service, show that there was a material falling off in the industry in 1915 compared with 1914. This was due, doubtless, to the general inactivity in construction work during the first half of the year on account of war conditions and also to the difficulty in obtaining imported creosote. The total output of treated timber of various classes in 1914 and 1915 is shown in the following table:

Kind	1914	1915	% Increase or Decrease
Crossties, number.....	43,846,987	37,085,585	D. 15.4
Piling, lin.ft.....	11,920,600	9,308,420	D. 22.0
Poles, lin.ft.....	2,526,256	4,282,174	I. 69.5
Paving blocks, sq.yd...	2,616,903	2,937,132	I. 12.3
Construction timbers, ft., b.m.....	118,173,612	142,009,004	I. 20.0
Crossarms, number.....	674,273	146,188	D. 78.3
Lumber and miscellaneous, ft., b.m.....	16,347,408	13,937,508	D. 14.8

To treat the 141,858,963 cu.ft. of timber shown for 1915 required 80,859,442 gal. of creosote, 33,269,604 lb. of zinc chloride and 4,899,107 gal. of all other preservatives, which included crude oil, coke-oven tar, refined coal tar, carbolineum oils, etc. Of the creosote used in 1915, 54%, or 43,358,435 gal. (41,333,890 gal. coal-tar creosote and 2,024,545 gal. water-gas tar) was domestic and 46%, or 37,501,007 gal., German and English oil.

Two Headgates on the Welland Canal were carried out on Apr. 30, at Lock 8, by the wooden steamer W. J. Anerell, bound for Cleveland, laden with package freight. Vessel and towpath gate were carried out into the lower reach. Navigation was delayed for about 8 hr., and damage is estimated at $3,000. The accident was caused by the vessel not being properly checked by cable upon entering the lock.

An Explosion in the Garbage-Reduction Works of the Pacific Reduction Co., Los Angeles, Calif., on Apr. 23, injured seven men, three of whom soon died, and damaged the works to the extent of some $15,000. The presumption is that gasoline used in the process of treatment was ignited by cigarette or otherwise. The plant has a reported capacity for treating 250 tons of garbage daily. The Cobwell system is used.

A Bridge Accident Occurred on Apr. 17 near Deputy, Ind., about 40 mi. north of Louisville, Ky., on the Indiana Division of the Baltimore & Ohio Southwestern R.R. This division is used by the trains of the Big Four system, as well as the Baltimore & Ohio. A derailed car in a Big Four freight train hit an end post of a bridge over Graham Creek and caused the collapse of the span. The span was a single track, pin-connected, through-truss bridge 208 ft. 6 in. long. The depth of water in the stream at the crossing and other conditions made the work of restoring the line at the break comparatively slow, and it was necessary for several days to detour trains around the break over the Pennsylvania tracks.

An Old Iron Bridge in Tonawanda, N. Y., was damaged by a flood in Tonawanda Creek on Mar. 28. The bridge is known as the Webster St., or "Long," bridge and connects the towns of Tonawanda and North Tonawanda. The bridge was built in 1875 by the Wrought Iron Bridge Co., Canton, Ohio, had three pin-connected Pratt truss 100-ft. spans, with a 28-ft. roadway and a 6-ft. sidewalk on each side. The failure of the bridge was due to the scour underneath the east channel pier. This scour was aggravated by two canal boats that had been torn loose from their moorings and lodged against the pier. One end of the pier settled vertically about 5 ft., lowering the ends of the spans resting upon it by that amount and stopping traffic over the structure.

Bids for Constructing a Wood-Stave Supply Main for the new water-supply of Aberdeen, Wash., will be received on May 31. The conduit will be 28 in. in diameter and 22 mi. long. (See "Engineering News," Mar. 30, 1916, p. 603.) The contract for 1,000,000 of the 2,000,000 staves required has recently been let to the Vance Lumber Co. for $23 per 1,000 ft., f.o.b. Malone, Wash. The freight rate to Aberdeen is $1.20 per 1,000 ft. Louis C. Kelsey, city engineer of Aberdeen, is engineer for the new supply.

The Garbage-Incinerator Lawsuit against Atlanta, Ga., brought by the Destructor Co., New York City, has been decided in favor of the company. The Federal district court has ordered the city to pay the company $135,000 in addition to the $125,000 already paid. The court has also declared that the city is liable for operating expenses met by the company for a considerable period. The mayor, who has been against the contract for the incinerator ever since he took office, has declared that the suit will be appealed, and the company has announced that it will stop operating the plant. The mayor has contended that the contract was not fulfilled in that the operating cost exceeds 25c. per ton and in that the ventilation of the main building is defective.

The Shipbuilding Industry in the United States is experiencing the greatest activity ever known. According to statistics collected by the Bureau of Navigation of the Department of Commerce, there were, on Apr. 1, under construction or contract in shipyards in the United States 360 steel vessels with an aggregate tonnage of 1,067,856 tons. Of these ships 176, with a tonnage of 823,651 tons, were ocean-going vessels, and 184 vessels, of 244,205 tons, were for use on the Great Lakes and inland rivers. The largest tonnage in any yard was that of the Union Iron Works of San Francisco, 151,458 tons. The New York Shipbuilding Co., Camden, N. J., had 126,305 tons; the Newport News yard, 119,521 tons; the American Shipbuilding Co., Cleveland, 93,800 tons.

Contracts for Two Miles of Subway Construction will soon be submitted for bidding by the Public Service Commission, New York City. These contracts comprise three sections—1, 4 and 5—of the new 14th St.-Eastern rapid-transit line, which is to be operated by the New York Municipal Railway Corporation. Section 1, which is 2,889 ft. long, extends from Sixth Ave. to Irving Place, in Manhattan, along 14th St. Section 2, east of here to the river tunnel, has not yet been made ready for bidding; Section 3, the river tunnel, was let recently. Section 4, which is 3,590 ft. long, extends along North 7th and Metropolitan Ave. from Bushwick to Manhattan Ave. Section 5, which is 3,620 ft. long, extends along Metropolitan and Bushwick Ave. from Manhattan Ave. to Meserole St. The subway is to be two-track and must be completed ready for operation in 22 months from date of contract.

The Standard-Barrel Law, which was enacted by Congress a year ago and goes into effect on July 1, fixes the capacity of a standard barrel at 7,056 cu.in. (4⅛ cu.ft.) for all dry commodities other than cranberries. This classification includes of course such materials as lime and cement. Lime manufacturers have already had introduced into Congress a bill establishing standard lime barrels of large size and small size, the large barrel to hold 280 lb. and the small barrel 180 lb. No action appears to have been taken by the cement manufacturers, however, and unless some special legislation is enacted before July 1, a manufacturer using the old cement barrel containing 3.69 cu.ft. is liable to the penalties fixed by the law. Probably the reason why the cement manufacturers have not taken more interest in amendatory legislation is that only a very small amount of cement is shipped in barrels nowadays.

Sewage Disposal for Los Angeles County, California, will go without further study for a time at least. In January the County Board of Supervisors appointed a Commission of Sanitation Engineers to report on sewage disposal for the whole county. The commission soon reported that an investigation of the subject would take a year and cost $45,000, including salaries of $3,000 for each of the five commissioners. (See "Engineering News," Feb. 24, p. 382, and Mar. 9, p. 486.) The supervisors appear to have thought that the desired report could be made in a few weeks and for a slight expense. On learning that they were wrong and that Pasadena, South Pasadena and Alhambra appeared to be getting their joint sewage-disposal project (see "Engineering News," Apr. 13, 1916, p. 725) in such shape that it could not be blocked (the apparent chief object of the proposed investigation), the supervisors have called a halt.

Large Hotels Connecting with the Railway Terminals in New York City are under way. The Pennsylvania R.R. has just announced the projected construction through a subsidiary of the Hotel Pennsylvania in the plot just east of its Manhattan terminal, lying between 7th Ave., 32d St., 33d St. and the Gimbel store. This plot is 200x400 ft. in area and will be occupied by a 23-story hotel building eventually to have 2,200 bedrooms, though at present a 1,000-room capacity is planned. Communication through the basement will be made with the terminal and with the Seventh Ave. subway. Excavation work has already started. The New York Central lines already have built the Biltmore, opening into the Grand Central terminal on the east, and have announced their intention to erect a large, popular-price hotel to the west of the terminal, on the northwest corner of 42d St. and Lexington Ave. Such a hotel would also connect with the Diagonal station of the New York City subway system.

State-Aid Road Funds in Pennsylvania cannot be used to construct state highways in boroughs or in townships, according to opinions just rendered by William H. Keller, First Deputy Attorney General of that state. The effect of the decision is to make a clear distinction between state-aid roads and state highways and the money that can be drawn upon by the state to pay for each. State-aid roads in Pennsylvania are roads built one-fourth at the expense of the borough or township in which they lie, one-fourth at the expense of the county and one-half at the expense of the state. Heretofore some of the state highway funds have been used for constructing state-aid roads in boroughs or in townships. Hereafter, according to the opinion, all work on state highways must be paid for by the state out of money appropriated for the construction, maintenance and repair of state highways on the one hand, and on the other hand state-aid money must be used on roads that are not state highway routes.

Two New Salvage Companies have been organized for the purpose of raising and stripping sunken merchant vessels. One of these concerns is the Interocean Submarine Engineering Co., organized in Albany, N. Y., with $125,000 of 7% cumulative preferred stock and 10,000 shares of common. At first, this company will work along the Atlantic Coast, but it is proposed eventually to extend operations to all seas. The president is Rear-Admiral Colby Mitchell Chester, U. S. N., retired, and the principal financial backers are George F. Baker, Charles Sabin, Albert H. Wiggin, Percy A. Rockefeller and G. M. P. Murphy. The vice-president is Chief Gunner George David Stillson, U. S. N., retired, who was engaged on the work of raising the submarine F-4, near Honolulu. The offices of the company are in the Equitable building, New York City. The other concern is known as the Deep Sea Salvage Corporation. H. L. Bowdoin, Bayonne, N. J., who is president, says that with the aid of a steel diving suit his company will be able to work at depths of 600 ft. Mr. Bowdoin states that the Merritt-Chapman Wrecking Co. will furnish ships and men for the salvage work as soon as the Deep Sea Salvage Corporation is prepared to furnish the new diving apparatus.

Scholarship in Chemical Engineering—The Chemists' Club of New York City announces the establishment of a scholarship fund, the income from which, approximately $[illegible] per year, is to be devoted to assisting financially deserving young men to obtain education in the field of industrial chemistry or chemical engineering. This scholarship has been endowed by Dr. Victor G. Bloede, a manufacturing chemist, of Baltimore. Its benefits will be open to properly qualified applicants without restriction as to residence, and may be effective at any institution in the United States which may be designated or approved by the Chemists' Club. Applicants must, as a minimum qualification, have completed a satisfactory high-school training involving substantial work in elementary chemistry, physics and mathematics and present a certificate showing that they have passed the entrance examination requirements of the College Entrance Examination Board or its equivalent. Preference will be given to young men who have supplemented these minimum qualifications with additional academic work, especially in subjects which will form a suitable groundwork for the more advanced study of applied chemistry and chemical engineering. All inquiries should be addressed to the Bloede Scholarship Committee of the Chemists' Club, 50 East 41st St., New York City. Applications for the academic year 1916-17 should be in the hands of the committee on or before June 1, 1916. The scholarship will be awarded and candidates selected and notified on or before July 1, 1916. Doctor Bloede, the founder of the Bloede Scholarship, was born in Dresden, Saxony, in 1849 and began his technical education at Cooper Institute in New York City. Later he established himself as a manufacturing chemist in Brooklyn. In 1873 he organized the Victor G. Bloede Co., of Baltimore, of which he is president. He has been prominent in philanthropic work for many years, having presented to the State of Maryland its first hospital for advanced consumptives.

PERSONALS

Mr. Ralph Hamlin, Assoc. M. Am. Soc. C. E., Chief Engineer of Pike & Cook Co., Builders, Minneapolis, Minn., has been elected Vice-President and Director of the company.

Mr. Claude S. Gordon, Pyrometer Expert of the Illinois Steel Co., South Chicago, has opened a private laboratory and will conduct a service department as Consulting Pyrometer Engineer.

Mr. J. W. Lee, Jr., who recently resigned as Publicity Agent of the Pennsylvania R.R., will soon move to New York City, where he will become associated in business with Mr. Ivy L. Lee.

Mr. J. D. Scott, formerly power salesman of the Portland (Ore.) Railway, Light and Power Co., has been appointed Assistant Engineer in the office of the General Superintendent of the company.

Mr. Paul Riston, Assistant Editor of the Reynoldsville (Penn.) "Star," has been elected City Engineer of Punxsutawney, Penn. Mr. Riston studied civil engineering at Princeton University for three years.

Mr. Henry W. Dun, Jr., Jun. Am. Soc. C. E., has resigned as Assistant Engineer in the office of the City Engineer of Albany, N. Y., to enter the Engineering Department of the Atchison, Topeka & Santa Fé Ry.

Mr. Milo R. Maltbie, former member of the Public Service Commission of the First District for the State of New York, has been appointed City Chamberlain of New York by Mayor Mitchel. Mr. Maltbie succeeds Henry Bruère.

Mr. Henry C. Lang, formerly connected with the Estimates Division of the Public Service Commission for the First District of New York State, has resigned to enter the employ of the Graves Engineering Co., Inc., New York City.

Mr. Alexander C. Brown, Jun. Am. Soc. M. E., Vice-President of the Brown Hoisting Machinery Co., Cleveland, Ohio, has been appointed General Manager of the company to succeed Richard B. Sheridan, M. Am. Soc. M. E., who recently resigned.

Mr. Clyde B. Aitchison, member of the Public Service Commission of Oregon, has resigned to become Solicitor of the National Association of Railway Commissioners at Washington, D. C. Mr. Aitchison became a member of the Oregon commission in 1907.

Mr. Joseph W. Hunter, M. Am. Soc. C. E., First Deputy Commissioner of the Pennsylvania State Highway Department, has automatically become Acting Commissioner of Highways on account of the death of Robert J. Cunningham, noted elsewhere in this issue.

Mr. W. H. Wood, recently in charge of the steam-boiler plants of the American Writing Paper Co., Holyoke, Mass., has been appointed Superintendent of Power Plants in the Electrical Department of the Baltimore & Ohio R.R., with headquarters in Baltimore. He succeeds T. F. Foltz, who recently resigned.

Mr. George B. Harley, formerly an Assistant in the office of the Publicity Agent of the Pennsylvania R.R., has been appointed Publicity Agent of that railroad. He succeeds Mr. J. W. Lee, Jr. Mr. Harley has been with the Publicity Department since June, 1914. Previous to that he was on the reportorial staff of the Philadelphia "Press" from 1908 to 1910, the Philadelphia News Bureau from 1910 to 1914, and from February to June, 1914, was on the staff of the Philadelphia "Public Ledger."

Mr. James E. Gibson, General Superintendent of the Kansas City (Mo.) Ry., has been appointed General Manager of the system. He entered the service of the Metropolitan Street Ry., Kansas City, in 1904, as clerk in the accounting department. In 1905 he was appointed Assistant to the President and in 1909 became Superintendent of the 48th St. and Harrison division of the company, where he remained until 1910, when he was appointed to the office of General Superintendent. He served in that capacity through the reorganization of the Metropolitan as the Kansas City Ry. Mr. Gibson is a graduate of the University of Missouri.

Mr. James H. Van Wagenen, Assoc. M. Am. Soc. C. E., who has been with the International Boundary Commissions for several years in charge of field parties engaged on the survey of the International Boundary Line between the United States and Canada, has been appointed Engineer to the Commissions, in charge of the direction of all the field and office work of the United States section of the Commissions. Mr. Van Wagenen graduated at the University of Missouri in Civil Engineering in 1908 and previous to his engagement with the Boundary Commissions was with the U. S. Geological Survey on topographic surveys in North Dakota, and later was an Assistant Engineer with the Illinois Highway Commission.

Mr. W. E. Skinner, Assoc. Am. Inst. E. E., President of W. E. Skinner, Ltd., Winnipeg, Man., has opened an office as Consulting Engineer at 415 Plymouth Building, Minneapolis Minn. For nearly 10 years Mr. Skinner was in the employ of the Westinghouse Electric and Manufacturing Co. at East Pittsburgh and Buffalo. He acted as Consulting Engineer for the Hawaiian Electric Co. from 1900 to 1904, at which time he entered the employ of the Canadian Westinghouse Co., Ltd., at Hamilton, Ont., and later was in charge of that company's Winnipeg office until 1907, when he organized the firm of W. E. Skinner, Ltd. Mr. Skinner has also for several years acted in a consulting capacity to the Public Utilities Commissioner of Manitoba.

Mr. Theodore Speiden, Jr., who was appointed Superintendent of the Chattanooga and Nashville divisions of the Nashville, Chattanooga & St. Louis Ry. the early part of this year, has been made Assistant General Manager of the road, with headquarters at Nashville, Tenn. Mr. Speiden entered the Engineering Department of the Louisville & Nashville R.R. in 1899. He was promoted in 1905 to the position of Roadmaster, which he held until 1914. The last two years of that time he was also in charge of the reconstruction of 14 mi. of the Lewisburg & Northern R.R., the only portion of that line built with the company's forces. In 1914 he was appointed Assistant Superintendent of the Chattanooga division of the Nashville, Chattanooga & St. Louis Ry., and in July, 1915, was made Superintendent of the division.

OBITUARY

Thomas J. Keane, Superintendent of Asphaltic Construction in the Pennsylvania State Highway Department and Assistant at the department's testing laboratory, died at his residence in Harrisburg, on Apr. 25. He had been connected with the State Highway Department since 1912. Previous to that time his home was in Pittsburgh.

Albert Frank Brewer, General Superintendent of the Oregon Short Line R.R. at Pocatello, Idaho, died from an attack of heart failure while visiting a friend in Cleveland, Ohio, on Apr. 17. Mr. Brewer had been connected with the Oregon Short Line for 20 years. Previous to that time he was Superintendent of Transportation of the Denver & Rio Grande R.R., at Denver. He was 54 years old.

Robert J. Cunningham, State Highway Commissioner of Pennsylvania, died at his home in Sewickley, Penn., on Apr. 26, at 56 years of age. He was born in Elizabeth, Allegheny County, Pennsylvania. For a time Mr. Cunningham engaged in newspaper work. In 1903 he was elected Comptroller of Allegheny County and served until 1906, when he was elected State Senator. He was appointed Highway Commissioner in 1913 by Governor Brumbaugh.

Charles Henry Preston, M. Am. Soc. C. E., Architect and Civil Engineer, died at his home in Norwich, Conn., on Apr. 18. Mr. Preston started his business career as a millwright. He spent five years as an apprentice and journeyman with the firm of McQuirk & Bacon, Architects and Builders, and then studied architecture at Northwestern University for several years. Mr. Preston built some of the largest buildings in Norwich and other Connecticut cities and during the past year had drawn plans for the new buildings constructed at Taftsville to replace those destroyed by a fire which occurred there a year ago.

ENGINEERING SOCIETIES

COMING MEETINGS

CANADIAN RAILWAY CLUB.
May 9. Annual meeting in Montreal. Secy., James Powell, P. O. Box 7, St. Lambert, P. Q.

RAILWAY DEVELOPMENT ASSOCIATION.
May 9-11. Annual meeting in New Orleans. Secy., H. O. Hartzell, B. & O. R.R., Baltimore, Md.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 9-11. Annual meeting in Chicago. Secy., Franklin H. Wentworth, 87 Milk St., Boston.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
May 10-12. Convention in Pittsburgh. Secy., F. D. Mitchell, 1510 Woolworth Building, New York City.

TAYLOR SOCIETY.
May 11-13. Conference on scientific management in Cleveland. Secy., H. W. Shelton, Hanover, N. H.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Hotel Sherman, Chicago. Secy., J. G. Crawford, 702 East 51st St., Chicago.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 16-19. Eighth convention in New York City. Secy., D. L. Gasgill, Greenville, Ohio.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 17-20. Annual convention in Galveston, Tex. Secy., H. S. Cooper, Slaughter Building, Dallas, Tex.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 22-26. Convention in Chicago. Secy., T. C. Martin, 29 W. 39th St., New York City.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Annual meeting in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN IRON AND STEEL INSTITUTE.
May 26-27. General meeting in New York City. Secy., J. T. McCleary, 61 Broadway, New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

MASTER CAR BUILDERS' ASSOCIATION.
Annual meeting, Atlantic City, N. J., June 14-16, 1916. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
Annual meeting, Atlantic City, N. J., June 19-21, 1916. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

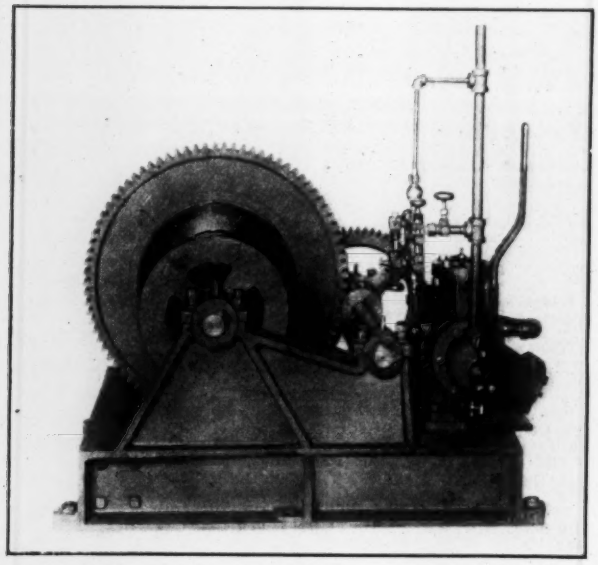
AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

American Society for Testing Materials—The annual meeting will be held at the Hotel Traymore, Atlantic City, N. J., June 27-30, 1916, the last session being held Friday afternoon instead of Saturday morning, as has been the recent custom. The provisional program shows three sessions on Tuesday and two each on Wednesday, Thursday and Friday. The nominating committee has announced the following nominations: President, A. A. Stevenson; vice-president, S. S. Voorhees; executive committee, W. H. Bassett, John Brunner, G. W. Thompson, F. E. Turneaure. The following officers hold over for another year: Vice-President, W. H. Bixby; executive committee, J. H. Gibboney, W. K. Hatt, J. A. Mathews, Edward Orton, Jr.

Appliances and Materials

New Two-Speed Hoisting Engine

A new two-speed hoisting engine has just been developed by the J. S. Mundy Hoisting Engine Co., Newark, N. J. The engine has three 3½-in. cylinders (2½-in. stroke) 120° apart, with connecting-rods coming to a single pin on a crank disk. It is designed to run under constant steam pressure (100 lb.),



NEW MUNDY TWO-SPEED HOIST

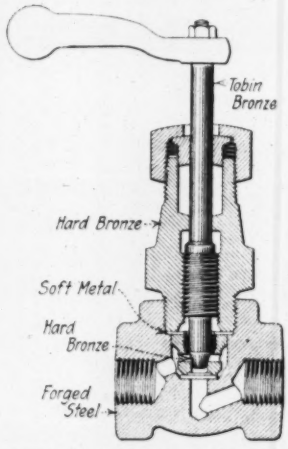
at constant speed (500 r.p.m.) and is particularly light, compact and portable, being 40 in. long, 25 in. wide and 32 in. high.

The engine is geared 31:1 for boom swinging. The maximum line pull is 2,000 lb. at 40 ft. per min. rope speed. The drum is 10 in. in diameter by 12 in. long and is on a 2⅞-in. shaft. The complete hoist weighs 1,000 lb.

* * *

High-Pressure Valve

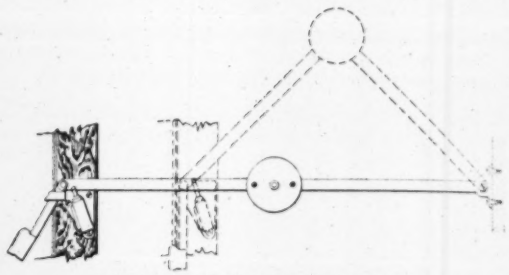
A line of forged-steel globe and angle valves has been designed by the Crane Co., Chicago, for hydraulic pipe lines, compressed-air and gas containers, engine-starting air systems and other extreme-pressure service. They are designed for hydraulic installations having 6,000 lb. per sq.in. working pressure not subject to shocks and to 3,000 lb. subject to extreme shock. The accompanying sketch shows the construction. The body is of forged steel liberally proportioned. The bonnet is of tough close-grained bronze. The stem is of rolled Tobin bronze or Monel metal; a lever handle is required. A renewable seat bushing is used, of hard bronze or Monel metal; this slips into the body, bearing on a soft-metal gasket at the bottom and having another soft-metal gasket between it and the bonnet. For sizes of 1 in. or less the bonnet has a hexagon section to facilitate removal; for 1¼-in. valves and larger the bonnet is bolted on. The stem ends in a long tapered plug that seats on the removable bushing; the thread is long and fine pitched. The stem has a shoulder that seats on the bonnet when the valve is wide open—permitting packing when the valve is open. The stock sizes range from ⅜ to ¼ in.; larger sizes are made to order.



CRANE HIGH-PRESSURE VALVE

Closer and Lock for Sliding Doors

A simple but effective device for automatically [illegible]ing and locking elevator and other heavy rolling doors [illegible]een marketed by the Reliance Ball Bearing Door Han[illegible]Co., 30 East 42nd St., New York City. As shown in the [illegible]sh, the device consists of two metal arms and a plain tog[illegible]oint and operates by means of a flat spiral spring and [illegible]vity. One end of one metal arm is pivoted to one side of a [illegible]ling door; one end of the other arm is pivoted to the door [illegible]ing. The free ends of the two arms meet in the cent[illegible]in a toggle joint mounted in a flat disk containing a spiral [illegible]ring. The two arms are in alignment horizontally across t[illegible]oor, and a horizontal pull at the lever handle breaks the joint, unlocking the door. As the door is opened and slid [illegible], the arms rise with the disk at the toggle joint, forming an inverted V. When pressure on the lever handle is releas[illegible], the



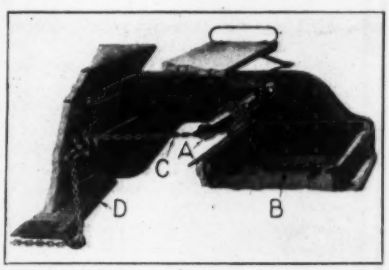
"RELIANCE" DOOR CONTROLLER

spring at the top of the V and the weight of the disk cause the door to slide silently shut and automatically lock as the two arms resume again their horizontal alignment. A liquid check reduces the speed of the door as it is about to close and eliminates all noise and jar.

* * *

Distributing Device for Dump-Wagons

To regulate delivery through the drop doors of dump-wagons built by the Studebaker Co., South Bend, Ind., the device shown is being used. The winding roller A has a chain B which can be slipped over a hook bolt in the platform at the driver's seat. This limits the revolution of the winding roller, so that the chain C holds the door D instead of over-



DELIVERY-CONTROL DEVICE FOR DUMP WAGONS

hauling and letting the door drop to its full opening. The hook is within easy reach of the driver from his seat, and by varying the length of chain between the hook and the roller the doors can be held at any width of opening, thus allowing the material to be distributed as the wagon moves forward.

* * *

Wearing Plates for Valves

In response to a demand for a steam or water valve that can easily and quickly be made tight without grinding, the O'Malley-Beare Valve Co., Chicago, has produced a design with the valve head and seat made up of superimposed uniform plates held by nuts. When a valve leaks from wear, the bonnet is taken off and a plate from both the seat and the head is removed. New plates can be put on, or the retaining nuts can be tightened up on the remainder. The multi-plate design is now made for all services; the plates are made of brass, composition nickel, Monel metal, etc.

* * *

Gasoline-Engine Starter

A new attachment for starting small gasoline engines has been devised by the Railroad Water and Coal Handling Co., Chicago. The scheme employed is first to inject a small quantity of explosive mixture into the compression space with the crank set just above the dead center and then to fire the mixture by moving the igniter. Compressed air for atomizing and injecting gasoline is supplied by a hand pump.

Enciclopedia en Español de Maquinaria para Construcciónes, Página 84

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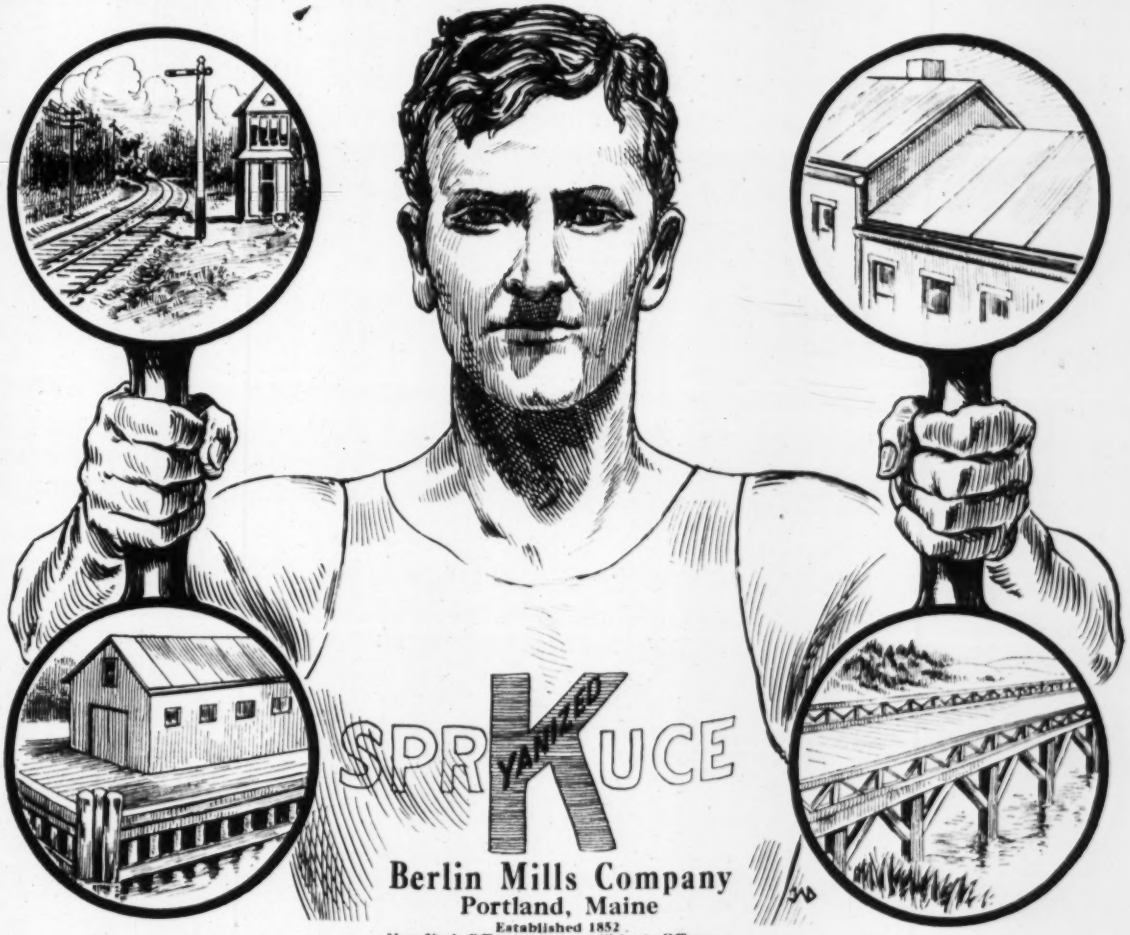

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The lightness and strength of this material recommends it for bridges, interior timbering, trestles and so forth.

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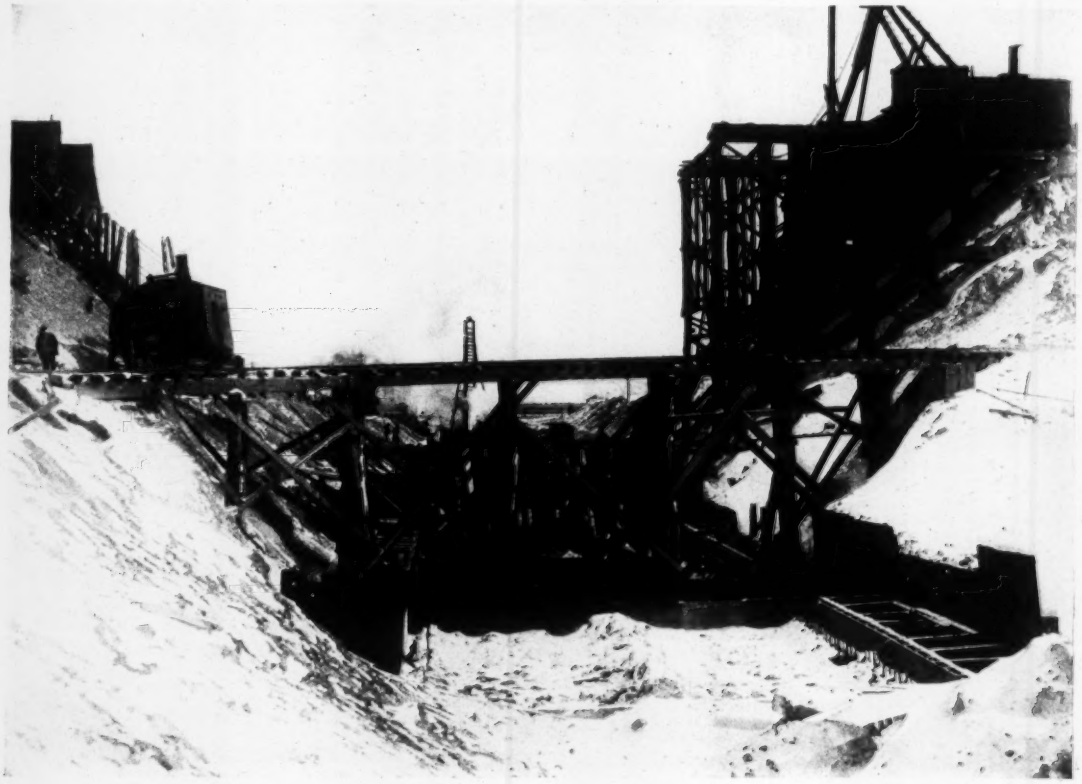

Lackawanna Steel Sheet Piling Used In Repairing The Irondequoit Break In The New York State Barge Canal

The large break in the New York State Barge Canal which occurred in Sept. 1912 at the crossing of the Irondequoit Creek culvert east of Rochester was temporarily repaired by partially refilling the washout with sand and building a timber flume supported by piles driven into the new fill. This temporary flume is now being permanently replaced by Myers & McWilliams, Contractors, under direction of the State Superintendent of Public Works, by excavating a trench across the old embankment down to water level, excavating a cofferdam below water level, building a new double-box reinforced-concrete culvert and replacing the embankment.

The new culvert is to be supported on wooden foundation piles the site of which is being kept open and free from seepage by walls of Lackawanna Steel Sheet Piling. Part of this cofferdam is shown in the picture above.

Something like 10,000 tons of Lackawanna Steel Sheet Piling have already been used in work on the New York State Barge Canal and in fact the success of this whole vast undertaking has hinged largely on the reliability, economy and watertightness of Lackawanna Steel Sheet Piling in the most exposed locations.

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Engineering News

VOLUME 75 MAY 11, 1916 NUMBER 19

Bridge Washouts in the Desert

To those engineers who think of Arizona as an arid region it may seem strange that the principal difficulties of highway engineers in this desert country are washouts. This was particularly brought home in the January floods of 1916, which carried away so many bridge structures in both southern California and southern Arizona. The occasional failures of these large structures in an unusual flood are generally widely heralded; but after all, such damage is but a fraction of the aggregate flood damage to scores of other structures, which are damaged or destroyed under similar conditions almost every year. There is probably no more perplexing and baffling problem before the highway engineers of the arid Southwest than that of how to build and how to protect their structures against the eccentricities of rivers like the Colorado and its numerous tributaries as the Gila, the Salt and many others. These streams carry enormous amounts of silt, and their beds are built up of this material from a great depth. In times of low water—some of these streams become practically dry at times—the river beds grow up with willows and cottonwood trees that catch the silt and for a time give security to the banks. When extra-high water comes, the trees are uprooted and form temporary barriers that deflect the current to one bank or the other. Then a scouring commences, the end of which no man can foresee.

FIG. 1. VIEW OF SALT RIVER VALLEY NEAR TEMPE, ARIZ., SHOWING THREE BRIDGES

Typical conditions in these valleys are shown in Fig. 1, which gives a better idea than a topographic map. This is a view near Tempe, in the Salt River Valley, a few miles above Phoenix. In the foreground are three spans of the Santa Fe railway bridge, the remainder of which was washed out several years ago. Beyond is the concrete-arch state-highway bridge described in *Engineering News*, Mar. 28, 1912, p. 578, by James B. Girand, then Territorial Engineer. The third bridge is that of the Arizona Eastern R.R. The present course of the river can be seen at the extreme right.

Fig. 2 shows graphically what happens under flood conditions. It appears to be a view of a limitless lake; but if one looks closely, one can make out a bridge in the background. This is a 14-span reinforced-concrete girder bridge 700 ft. long, carrying a state highway across the Gila River, near Florence, Ariz. The bridge itself is undamaged, but the river has left its old channel and washed away 1,200 ft. of the approach embankment on the south end of the bridge. The waste of waters in the foreground of the view is flowing over this approach. It is of course impracticable and impossible with the funds available to extend the bridge across the new channel. Instead, it is proposed to compel the stream to return to its former channel. Work has already been begun by State Engineer Lamar Cobb to open up a diversion channel leading the river to its proper place underneath the bridge. To do this it will probably be necessary to build a temporary dam or dike across the stream at the entrance to the channel. The embankment will then be replaced and probably rip-rapped, if sufficient funds are available. At best this is but a temporary expedient, since there is no assurance that the river will not cut the same caper again.

A washout of almost identically the same character occurred in Pima County, where the county engineer, W. C. Goetz, is deflecting the current back under the bridge by means of jetties made of fencing fastened to 2-in. boiler tubes, 14 ft. long, driven 10 ft. into the ground. Two rows of this wire fencing are used, spaced 4 ft. apart, and the space between is filled with brush weighted with stone to form a mattress dike or crib.

This is the favorite method of protection where the stream is not too large and conditions permit. Fig. 3

shows work of a similar nature designed to prevent the erosion of the side of the Grand Canal in the Salt River Valley, at a place where it comes close to the river bank. The jetty here consists of a stepped earth embankment faced with a brush mattress made by filling a 12-in. space between a wire fence and the face of the embankment with willow brush. Willow sprouts are being planted along the toe of the embankment to afford a permanent protection to the fill. Walter Ward is the construction

FIG. 2. GILA RIVER NEAR FLORENCE, ARIZ., IN FLOOD
Note bridge in the background

engineer, Salt River project, United States Reclamation Service. W. S. Cone is Project Manager.

A bridge-approach washout similar to those described, but not so serious, occurred at the Central Ave. bridge, Phœnix, Ariz. Here the Salt River subsequently returned to its normal channel of its own accord.

When it is remembered that the silt of many of these streams extends to such a depth that it is impossible to found the piers on rock and that in flood times the streams carry enormous amounts of drift and silt, it is not to be wondered at that failures are frequent. It is very hard under the circumstances to guarantee success; for if the bridge be strong enough to resist, it only assists in diverting the flood around one end—and the loss of a fill of any considerable depth mounts into money pretty rapidly.

Engineering Society Service*

By Edmund M. Blake†

The building up of an engineering society depends upon the correlated service of every member. Application for membership and its acceptance should carry with it not only the willingness to give, but the intention of giving, service. We who are following the greatest profession in the world have adopted engineering as our life work only after careful thought, deep consideration of all the branches of life's activities and usually a long scientific or practical preparation. If we are not loyal to engineering as the profession we have ourselves chosen, we should abandon it at once. If we are loyal to it, then the upbuilding and strengthening of our chosen profession should be one of the primary motives of our work. We cannot draw from a bank unless we have put in something to draw upon, and the more we put in the more we can draw out. It is equally true of the engineering profession. We must invest in it all we have, constantly adding to that investment as the years go by, if we are to share in the full returns.

An engineering society represents a coöperative effort by the engineering profession to consolidate its members into a concrete and united organization for the upbuilding and strengthening of the profession, for the benefits of personal contact and professional interchange of engineering knowledge, ideas and advice, for the purpose of commanding a broader recognition and a higher valuation of the engineering profession by the public for the publication and dissemination of the best in engineering theory, design and practice and the compilation of data. The individual member should be instilled with a true spirit of service, with an ambition to contribute toward the accomplishment of these purposes more than his share and with a very clear realization that his application for membership in the society is not accepted primarily as adding one more wheel unit to the installation, but rather in the nature of additional second-feed of flow to be credited to plant capacity.

With this conception firmly established in his mind, the engineer who joins the society will consider of first importance the question of what he can add to the society and not of what he can get out of the society in return for his annual dues. Service for the society will follow, and soon there will be no need of arguing the other

FIG. 3. EARTH JETTY WITH BRUSH MATTRESSES, GRAND CANAL, SALT RIVER VALLEY

side—that of the benefits to be received from membership in the society. This conception will not foster any false valuation of present personal contribution to the society, but rather will create an ambition to make the net final contribution represent the maximum possible individual output, always remembering that the engineering society is the one great concrete medium of contribution to the engineering profession.

The Boston Society of Civil Engineers was founded in 1848 and is the oldest engineering society in the United States. Its membership comprises those interested in mechanical and electrical, as well as in civil, engineering, and its officers have included prominent members of all three branches of the profession. Today its total active membership has reached one thousand, composed of men-

*From the "Journal" of the Boston Society of Civil Engineers for April, 1916.

†Civil Engineer, Brookline, Mass.

bers, junior and associate members and honorary members, and it has established a permanent and safely invested fund of over $37,000. It seems, to use an inadequate simile, like a big battleship ready for launching; but that does not mean necessarily a membership limited to one thousand with a waiting list, nor a permanent fund of only $37,000, nor in any way a reflection adversely upon the net result of past efforts, but rather the highest commendation for the achievements and distinction already won. The society is now 68 years old. Many of its present members may not answer the one-hundredth anniversary roll call in 1948. It can never hope to approximate the membership total of the American Society of Civil Engineers, but in quality, solidity and scientific achievement, in service to the engineering profession, fraternal *esprit de corps* and its contribution to the engineering literature of the world it is possible for the Boston Society of Civil Engineers to establish its claim as the foremost engineering society in the United States on or before its centennial anniversary in 1948.

Power Possibilities of Federal Irrigation Projects*

By A. P. Davis†

The United States Reclamation Service in the construction of irrigation works has on many of its projects a byproduct in the shape of hydro-electric power, usually in blocks too small to be considered in connection with any extensive electrochemical industry, but in a few cases large enough to be thus utilized. In addition thereto, investigation has been made of possible power development for the primary purpose of pumping water for irrigation.

On the Minidoka project in southern Idaho a diversion dam provides storage and a head of 46 ft. upon the wheels of a 10,000-hp. power plant. This capacity can be doubled at a reasonable cost. The power now developed is fully utilized only during the summer months. Undeveloped power sites along the Snake River in the same region could be made to produce several hundred thousand horsepower for eight or ten months in the year.

On the Boise project in Idaho the Reclamation Service has built a high masonry storage dam about 240 ft. above the river bed. More than 1,000,000 acre-ft. of water have to pass this dam site every year. Power development here could utilize the 60- to 230-ft. head in the reservoir. The quantity of water available during the summer would be about 5,000 sec.-ft., but in the winter only about 200 sec.-ft. Provision has been made for the convenient installation of 17,000 hp. in generating units.

The Pathfinder dam on the North Platte River, Wyoming, is 210 ft. high, forms a reservoir of 1,100,000 acre-ft. and intercepts an annual flow that varies from 1,000,000 acre-ft. to over 3,000,000. The water of low and average years is all required for irrigation. It could be utilized for power as it comes from the reservoir, but would be available only six or eight months of the year, and the head would vary from 60 to 200 ft. There has been no power development here as yet.

A large amount of power might be obtained during the irrigation season at the Elephant Butte dam in New Mexico, but usually during two or three months of the winter, there would be no power. The available head will vary from 65 to 185 ft., and the maximum quantity of water drawn will be about 2,500 sec.-ft. During eight months of the year it would be possible to develop from 20,000 to 30,000 hp. The development of power was considered in designing the dam, and six 5-ft. power outlets were installed.

On the Shoshone project, Wyoming, a masonry dam rises about 250 ft. above the river bed. This dam furnishes a storage reservoir of about 450,000 acre-ft. capacity, and water is stored primarily for irrigation purposes. The flow of the stream, however, when thus regulated is greater than required for the irrigable lands and will furnish a surplus of water that can be used for power purposes during the winter. The river falls rapidly below the dam site, and from 25,000 hp. in winter to 40,000 hp. in summer is feasible. With the high dam and a large reservoir already constructed, together with the proximity of limestone, sulphur, coal and phosphate rock, the Shoshone location constitutes one of the best localities for the establishment of electrochemical industries.

An investigation has been made of a large water-storage and irrigation project at the head of the Sacramento Valley, with a high dam at Iron Cañon near Red Bluff, Calif. The quantity of water available would vary from 3,700 sec.-ft. to about 5,000 sec.-ft., and the head would vary from 60 to 130 ft., furnishing some 25,000 to 35,000 hp.

Large power possibilities exist near the outlet of Flathead Lake, Montana. The flow is rarely less than 4,000 sec.-ft., and this can be increased to 10,000 by a dam converting the lake into a storage reservoir. Such a dam would produce a head of 340 ft. and make practicable the development of from 200,000 to 300,000 hp.

The Reclamation Service in coöperation with the State of Oregon conducted an elaborate investigation in 1914 of the power and irrigation possibilities that could be developed by the construction of a dam in the Columbia River at what is known as "Five Mile Rapids," near The Dalles. At this point the Columbia River channel suddenly reduces from a width of about 1,800 to 150 ft. and continues between two rock walls in a very narrow and deep channel. The plan proposed is to build a dam at the narrow neck where the river first enters this gorge and to excavate a power canal to a power house 1½ mi. below. The quantity of water available varies between 50,000 and 1,000,000 sec.-ft. The head for plant operation will range from about 45 to 105 ft. Nearly 480,000 hp. could be developed continuously, with the possibility of additional large blocks of power for a part of the year. It is estimated that this project would cost about $50,000,000.

At the Priest Rapids on the Columbia River above the mouth of the Snake River an average head of 60 ft. can be obtained, which with a minimum discharge of about 40,000 sec.-ft. gives over 200,000 hp. the year around.

Tidal Currents in the Bay of Fundy as a source of power are being investigated by engineers, according to a report by United States Consul Henry S. Culver, St. John, New Brunswick. The plan at present under investigation is the development of power from the swift tidal current in Minas Channel opposite Cape Split. The velocity of the tidal flow in Minas Channel is eight to ten knots. It is stated that a market for the power when developed may be found in cities with an aggregate population of nearly half a million, located within a radius of 100 mi.

*From an address before a water-power conference of the American Institute of Electrical Engineers and the American Electrochemical Society, Washington, D. C., Apr. 27, 1916.

†Director and Chief Engineer, United States Reclamation Service, Washington, D. C.

Building a Big Dam in Wilds

SYNOPSIS—A 70,000-cu.yd. gravity-section concrete dam is being built in Quebec Province 50 mi. from a railway. Part of the first great important storage and stream-control scheme ever attempted for power in America—that of the St. Maurice River, on which are the important hydro-electric plants at Shawinigan and Grand' Mère. Brief outline of the design of dam and notes on organizing contractors' forces for heavy construction and difficult transportation.

Designs and preliminary work have been completed for the construction of a 1,720-ft. concrete dam and the creation of a huge storage reservoir at the headwater lakes of the St. Maurice River in Quebec. The contractor is now engaged in the difficult work of providing

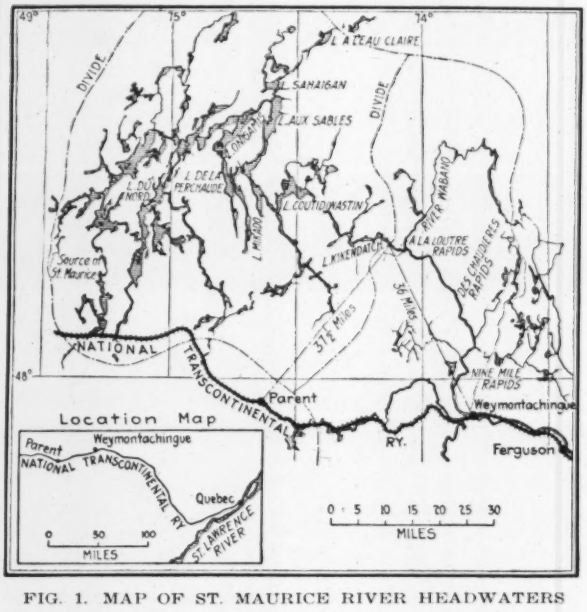


FIG. 1. MAP OF ST. MAURICE RIVER HEADWATERS

means of transportation for some 25,000 tons of material to the site. The progress thus made on the first great storage and river-control project for power in America actually to be undertaken (excepting the much smaller works on the Rangeley Lakes of Maine in the headwaters of the Androscoggin, as described in *Engineering News*, Mar. 9, 1911) is described in the following paragraphs.

Since the Quebec Streams Commission was organized, the control of the St. Maurice River has been the most attractive river-control project in sight, because of the important water powers on that stream and the marked improvement obviously possible. The records of daily flow at Shawinigan Falls showed a minimum of 6,000 cu.ft. per sec.—representing 0.37 sec.-ft. from each square mile of drainage area.

The early studies pointed to the vicinity of La Loutre Rapids (Fig. 1) as the logical place for a storage and control dam—at the lower end of a long intricate chain of lakes. The dam site is in entirely unsettled country, 37½ mi. in an air line north of the division point Parent on the National Transcontinental Ry. (Fig. 1) and 45 mi. from the junction of the Manuan and St. Maurice Rivers. Some 160 billion cubic feet could be stored, making a flow of 12,345 sec.-ft. for 150 days, or 6,172 sec.-ft. for 300 days. It was shown that the river could be regulated for 15,000 sec.-ft. at Shawinigan, leaving an over-supply in a very low year. The minimum flow in the lowest year (1906) was under 15,000 sec.-ft. for 255 days, with an average of 8,558 sec.-ft. during that time. But it was decided to regulate for only 12,000 sec.-ft. flow, in order to allow for loss of water in the 220-mi. flow to Shawinigan and to meet needs for floating logs at times when such water is not needed for power.

The important powers benefited are: Shawinigan (82,000 hp. at present, 164,000 future), Grand' Mère (41,000 hp. original, 82,000 future), La Tuque (32,300 hp. present and 78,000 future). These give a prior possibility of 155,300 hp. and a definitely planned extension to 324,000 hp. The figures quoted are based on fall and flow, with wheels of 80% efficiency.

Preparation of plans for the dam was intrusted to J. W. Thurso, with Edward Wegmann and J. M. McCarty as consulting engineers. The investigations in the field and the designing were under the direction of O. Lefebvre as Chief Engineer.

Test borings showed solid rock underlying the site. The plain gravity type was selected, and sliding gates were adopted. The profile was fixed after assuming an ice pressure of 50,000 lb. per lin-ft. acting at the crest level of the overflow weir; foundation uplift was neglected. The dam is to be 1,720 ft. long, of four straight sections (Fig. 2), with 851 ft. of spillway. Among the notable features are a movable sluice for logs and rubbish, a 375-ft. measuring weir and means for heating the gate chambers. A power house with two electric generating units was originally designed, but this was later eliminated—partly because the variable head (0 to 50 ft.) did not give good hydraulic conditions at the dam and partly because hand operation of gates will be satisfactory.

Inaccessibility of the Dam Site

The contract for the construction of the storage dam at La Loutre was awarded in July, 1915, by the Quebec Streams Commission to the St. Maurice Construction Co., Ltd., Montreal. The St. Maurice Construction Co. entered into an arrangement with Fraser, Brace & Co., Ltd., Montreal, for the supervision and execution of the contract.

The most unusual feature of the work is its great distance from the railroad. The dam site is situated 50 mi. (by route) north of the National Transcontinental Ry., being about equally distant from the stations known as Weymontachingue and Parent, both of which are very small communities, the first named being 75 mi. north of La Tuque, which was, at the beginning of the work, the nearest post office. The only train running over the new Transcontinental line between La Tuque and Weymontachingue was a mixed train that went on Tuesdays and Thursdays. The nearest telegraph operator was also at La Tuque, so that the communications with the work were extremely slow and difficult. Communication be-

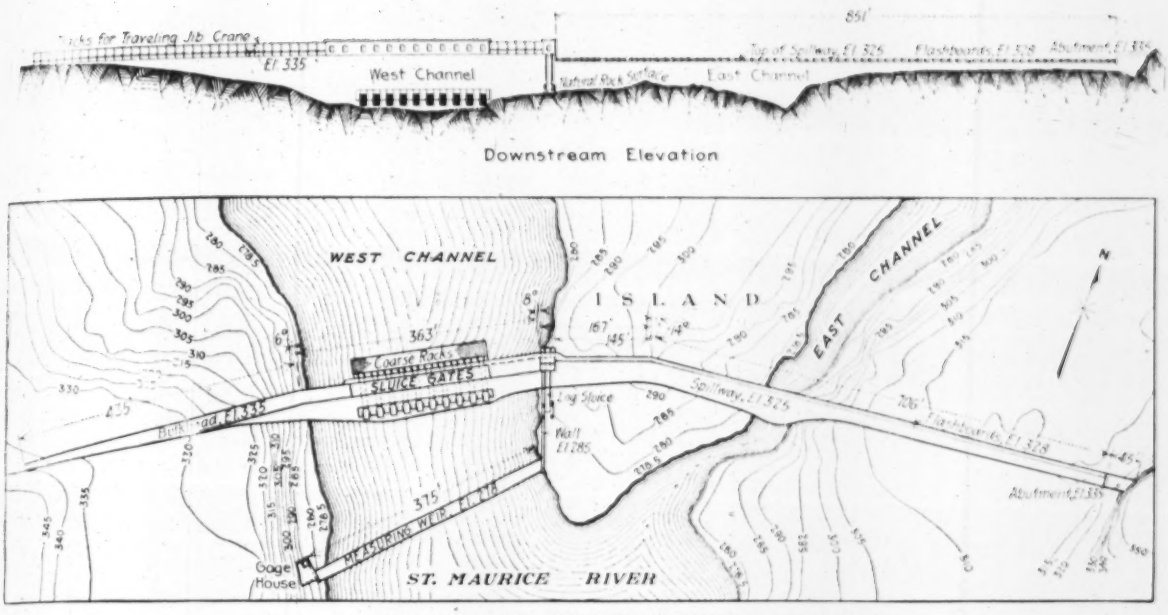


FIG. 2. PLAN AND ELEVATION OF ST. MAURICE CONTROL DAM

tween the railroad and the dam site was by means of canoes leaving the Transcontinental Ry. at Manouan, a place opposite Weymontachingue and near the crossing of the Manouan River. There was no station at this point, but all trains stopped there because of the existence of two trading places and three or four houses.

To reach the dam site at La Loutre from Manouan was a two-day journey by canoe. The first 30 mi. of river travel above Manouan was fairly smooth going, there being only one small rapid, up which the guides poled the canoes, the passengers taking to the bush for a short distance. At the 30-mi. point are the Chaudière Rapids, with a fall of approximately 30 ft. There are six other falls of greater or less descent in the remaining 20 mi. between this point and the dam site. All of these seven falls had to be passed by portage or carry.

The route up this river has been in use for a great many years, the goods of the Hudson's Bay Co. having been transported by this route to reach stations at Kikendatch and other points farther up the river. The country on both sides of the river is quite rough, being broken up by ridges and hills in every direction. The hills are from 100 to 500 ft. high, and the entering streams run in gullies of considerable depth, making travel along the banks extremely difficult. The soil is light and sandy, and the whole country is covered with a rather small growth of jack pine, spruce, poplar and white birch. The country is said to have been burned over, 50 or 60 years ago. Slight fires at more recent dates are indicated by limited areas completely grown up with small white birch. None of these show effects of very recent fires, and as a matter of fact, the country during the past few years has been very carefully patrolled by fire rangers employed by the St. Maurice Hydraulic Association. This work of the fire rangers is extremely vital to the preservation of the timber and has been organized in a very efficient way.

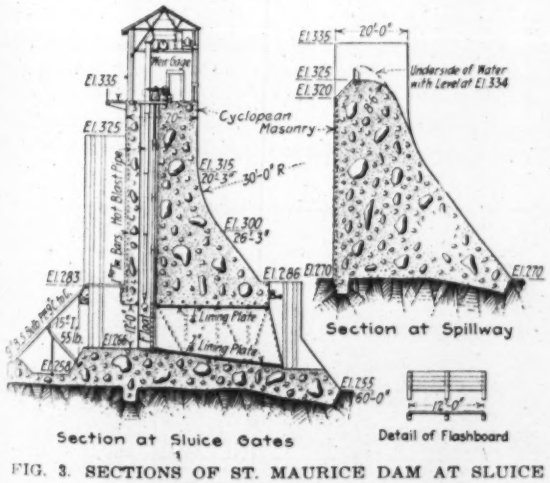

Cyclopean Masonry
Undersyde of Water with Level at El. 334
Section at Spillway
Section at Sluice Gates
Detail of Flashboard

FIG. 3. SECTIONS OF ST. MAURICE DAM AT SLUICE GATES AND SPILLWAY

Selecting a Transportation Route

The contractors virtually had a choice of two routes for reaching the place of work from the Transcontinental Ry. The route from Parent was investigated by competent railroad engineers. It was found to offer a line of easy grades and curves, but through a country so thoroughly burned that there was not enough timber in it even to provide the ties. It was estimated that the construction of a railroad through this country would require a line at least 48 mi. in length and that this could not be completed in time to permit any construction work at the dam during the summer of 1916. The second route was adopted by the contractors, utilizing river transportation for the 30 mi. on the St. Maurice River above Manouan or Weymontachingue as far as the Chaudière Rapids; a railroad 20 mi. long was required from Chaudière to the dam site at La Loutre, following the west bank of the St. Maurice River.

Railroad surveys were begun in August, 1915, the temporary headquarters being established in tents at Manouan. The survey parties were served by canoes carrying camp equipment and supplies up the river. A telegraph office

was established at Manouan, and within a very short time a siding was built close by for the contractor's service, and a small station was erected there. This station is known as Sanmaur. The railroad survey developed a good many difficulties because of the very rugged nature of the country, the impossibility of seeing any distance in the thick woods and the necessity of putting through the line at a low cost.

The estimated weight of material to be taken into the dam site is 25,000 tons. It is easily seen that this amount could not be transported by highway unless a good road were constructed, which would cost as much at least as a cheap railroad line. As for the method of all-river transportation, including portage, it was found to be barely possible to get in enough provisions to begin the railway work by this method.

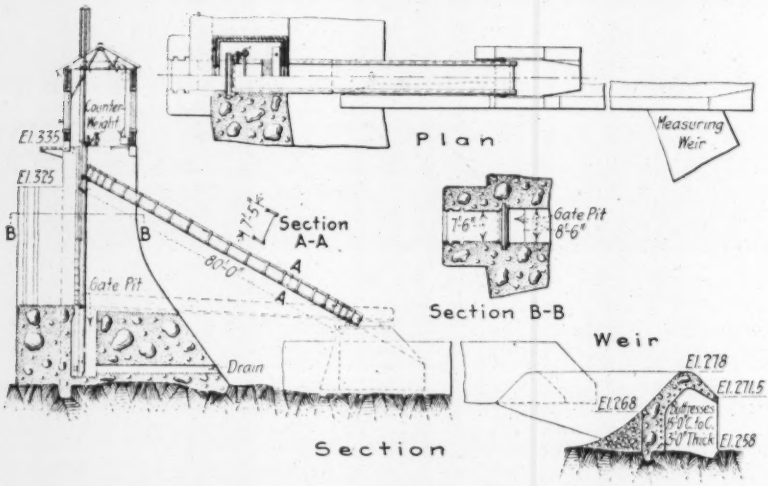


FIG. 4. PLAN AND ELEVATION OF LOG SLUICE

The railroad construction forces were sent up the river, beginning Sept. 12, 1915, and construction was started as rapidly as these forces could be taken in and supplied with provisions and equipment. It was found impossible to get horses in until the middle of October, but eventually during the fall over 800 men and 79 horses were at work. With the exception of the first two miles of railroad, the work proved to be extremely light. The sandy soil was easy to excavate, and very good timber for ties and trestles was found within a mile of the right-of-way.

The right-of-way follows the west bank of the river, as mentioned, and from Chaudière to within a mile of the dam site it runs through property owned in fee simple by the Brown Corporation, La Tuque. The corporation granted the right-of-way for contract purposes on favorable terms and has coöperated effectively with the contractor in every way. A telephone line was established through from the Transcontinental Ry. at Manouan to the dam site in 3½ mo. This line follows the river closely on the west bank as far as Chaudière, then follows the right-of-way to the dam site, with a short branch line running to the construction power-house site at La Loutre. The line is a metallic circuit and is built for the Streams Commission for permanent use in connection with the operation of the storage works. The contractor has the privilege of using the line during construction, and it has already proved to be almost indispensable.

The river transportation was begun with 18-ft. freight canoes. Portable gasoline motors were attached to them, and supplies for the early telephone and survey work were carried up by them. Gasoline motor boats were next brought up, being of the tunnel-stern type. The river was very low, and motor boats of the ordinary type were considered unsuitable because of the numerous rocks in the river bed. It was soon found, however, that Indian pilots who knew the river could avoid these rocks and that the usual type of motor boat could be used. The employment of pilots made possible running the boats at higher speeds, so that the trip between Manouan and Chaudière was soon cut down to 5 hr. going up and 3 hr. coming down.

Three ordinary scows of from 15 to 25 tons' capacity were constructed at Manouan for the transportation of supplies, and seven open scows were purchased lower down on the St. Maurice River. These scows, being only 10 ft. wide and 60 to 75 ft. long, were brought to Sanmaur on railroad cars and placed in service much more quickly than new boats could be constructed. These boats are practically bateaux; they steer easily by a 50-ft. oar in the hands of one man and are guided very readily even in the crookedest parts of the river. The contractors have adopted this general type and have now under construction a number with a freight capacity of 40 tons each. These scows are of extremely shallow draft and are eminently suitable for the service required, even at very low stages of the river. One small steam tug of the twin-propeller type was taken up and used during the fall of 1915. The rest of the towing was done by the gasoline motor boats. This equipment of boats carried in approximately 900 men for the railway work, about 65 horses, all plant required for the railroad construction and most of the supplies for the winter forces.

FIG. 5. EAST AND WEST CHANNELS OF ST. MAURICE RIVER AT LA LOUTRE DAM SITE

The river throughout most of the 30 mi. that had to be navigated is very crooked, with a large number of sand bars. The current averages 2½ mi. per hr. at ordinary stages of the water. About 12 mi. above Sanmaur there is the Nine-Mile Rapid, which is ½ mi. in length and in which the river has a fall of 3 ft. Above this rapid the current is swift for a distance of 7 mi. The freight boats could not well be towed through the Nine-Mile Rapid, so they were pulled for a distance of 2,500 ft. by a cable operated by an ordinary hoisting engine set up on the bank. The channel through the rapid was considerably improved by breaking up a number of boulders with dynamite and pulling the large fragments ashore by winches. Even after this improvement the rapid was always difficult to navigate. Careful surveys have now been made, and the channel will be further improved in the spring. It is not likely that the use of the hoisting engine will be done away with altogether, but it is thought that considerable time may be saved in pulling the boats up, and this will reduce the number of boats otherwise required for the service.

Hydro-Electric Power for Construction

A hydro-electric plant of 1,150 hp. is being erected by the contractors to furnish power for the construction work. The location selected is the La Loutre Rapids, 2¼ mi. below the dam site. The machines to be installed have two 39-in. wicket-gate wheels per unit, each unit to furnish 575 b.hp. at 150 r.p.m. with a net head

FIG. 6. HEAD OF CHAUDIERE RAPIDS

of 15 ft. The generators are 350-kv.-a. three-phase 2,400-volt 60-cycle alternators with 14-kw. 125-volt exciters mounted on the main shafts.

The power house is being built of reinforced concrete and extends as a dam across a small channel of the river between two islands. Another channel is used as a spillway. The whole structure sits on solid rock, the draft tube and tailrace being excavated behind coffer-dams built in November, 1915. It is expected that this plant will be in service by May, 1916. The contractors have already delivered at Sanmaur most of the construction plant, and most of this has been transported as far as Chaudière. The power-house machinery has been delivered at the site of the power house.

A large item of expense has been the 56-lb. rails for the railway line, which is being built standard gage. Oil-burning locomotives with standard-gage flat-cars and box-cars have been secured. The oil-burning locomotives are necessary to eliminate the danger of fire in the woods alongside the right-of-way.

The quantities of excavation at the dam site are comparatively small, being about 7,000 yd. of rock and 14,000 yd. of earth. The net quantity of masonry in the dam will be about 70,000 yd. A quarry has been located within a thousand feet of the dam site for obtaining concrete stone. There are good sand banks along the line of the railway close to the dam site.

The rock from the quarry will be dug with a 60-ton Marion steam shovel. It will be crushed by a 36x54-in.

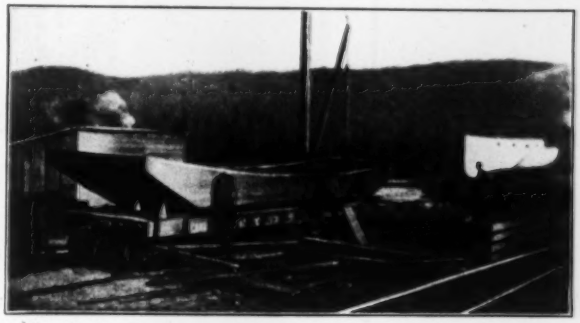


FIG. 7. CONTRACTOR'S FREIGHT BARGE AND MOTOR BOAT

Buchanan jaw crusher as a primary breaker, with a No. 7½ Telsmith secondary crusher and two small Austin gyratory crushers for the tailings. This crusher plant has a very large capacity compared to the quantity of crushed stone required. The large size of the primary crusher was decided upon so that the stone could be taken direct from the steam shovel without rehandling or breaking. It was estimated that the 36x54-in. primary breaker would easily take in any stone that could be handled by the steam shovel using a 2- or 2½-yd. bucket. Six-yard standard-gage cars loaded by the steam shovel will dump directly into the primary breaker.

The combination mixing and crushing plant is to be situated on a steep side hill very close to the dam and on the downstream side. It is planned to place the concrete and to handle the large stones, as well as forms, steel gates, gate-operating machinery, etc., by two overhead cableways and four derricks, the latter standing on cribs on the downstream side of the dam.

Unwatering the Site; Winter Work

Next to the problem of providing transportation to the dam site is the problem of unwatering the dam foundations. The river is divided into two channels at the dam site—one on the west side of the small island being 350 ft. wide, and the other on the east side of the small island being about 120 ft. The contractors plan first to shut off the small, or east, channel in the spring of 1916 and build the dam up to El. 1,278, which is ordinary low-water level on this side of the river. When this has been done, it is proposed to build a coffer-dam across the main, or west, channel high enough to force the water to pass over the dam in the small east channel during the entire construction of the dam in the west channel. The part of the dam in the west channel contains the 10 sluice gates; and when this part has been completed, the sluice gates will be opened and the section of the dam in the east channel will be carried up to full height.

There is a depth of 25 ft. of water in the west channel at ordinary stages of the river, and downstream coffers

FIG. 8. TRESTLE AND EMBANKMENT ON CONTRACTOR'S RAILWAY AT MILE 4

as well as upstream coffers will be required. Diamond-drill borings taken by the commission previous to the letting of the contract indicated a good rock foundation (Laurentian gneiss) all across the dam site, covered by approximately 5 ft. of sand and gravel for the entire length except on the west shore, where the cover has an average depth of 15 to 18 ft.

In addition to completing the telephone line and grading 13 out of the 20 mi. of railroad and beginning construction of the temporary power house the contractors have already erected a number of camps and dwellings at the dam site. Grading of the heavy cuts has been continued along the railway, and the construction of trestles has proceeded during the winter without interruption. The right-of-way has been cleared throughout its entire length, and the portions not yet graded are extremely light work that proved practically impossible of accomplishment after the winter weather set in. Cutting out timber for all purposes at the dam site has been carried on during the winter. About 4,250,000 ft. b.m. has been taken out and delivered inside of booms on the ice at a point on the river a short distance above the dam site. A sawmill has been erected and saw machinery installed at the dam site; all the lumber needed will be cut here.

A certain amount of transportation has been necessary during the winter, and this has been over the ice for the 30 mi. between Sanmaur and Chaudière and over the right-of-way from Chaudière to the dam site. There has been heavy snow all over this country since Nov. 15. The river choked up with snow and ice at two points on Nov. 16, making further navigation impossible. The river road did not become suitable for teaming until Jan. 1. A few teams were driven over the road during December with light loads, but there were several weeks when the only means of communication was by walking or the use of dog teams. The ice leaves the river between Apr. 20 and May 5.

New Concrete Building System

To reduce the large item of form cost in concrete building work, a new system has been developed in which floor forms are eliminated. The floor-slabs are cast on the lower floor and are hoisted thence to place; the columns are cast under the slabs when raised. The hoisting is done by a series of jacks, one at each column, operated in unison so that a large area of slab can be handled as a unit. Albert Peltzer, of 6726 Laflin St., Chicago, the inventor of the system, gives the following condensed description: "In this system the foundations and the first floor-slab are finished in the usual manner. Directly on top of the first slab the second floor-slab is cast; the third is cast on top of the second, and the two slabs are left to harden. Now, light structural-steel columns are placed in position, holes having been left in the slabs for this purpose. Next, jacks resting on these columns and attached to the slabs are applied, and the two slabs are raised to the proper height for the lower one. Forms are placed around the columns under the slab, and concrete is poured in from the top, the structural steel now forming the reinforcement of the column. The same operation—hoisting the slab and casting the columns—is repeated for the third floor-slab. Then if the building is to be higher, two more slabs are cast on the upper one, the columns are extended and the work continued as for the lower two slabs." Mr. Peltzer has designed for this service pneumatic jacks controlled from one point.

The process of building in this way has been patented. The inventor intends to rent the required apparatus to builders, and furnish the services of a skilled operator. Even a very large factory plant, it is claimed, can be built in such order of operations as not to employ more than 60 jacks at one time, costing less than $5,000. The saving over present methods is claimed to be at least 1c. per cu.ft.

Steel Aqueduct for Sewer

An original structure has just been built by the City of San Antonio, Tex., for a 6-ft. outfall sewer. Where this crosses a river valley, the concrete sewer section is changed to a 6-ft. steel pipe supported on a series of piers. The pipe is trussed by riveted steel queenpost trussing, and in this way spans of 81 ft. 10 in. are made possible. The pipe is hung directly to the vertical hangers of the trusses (there being no floor system), and

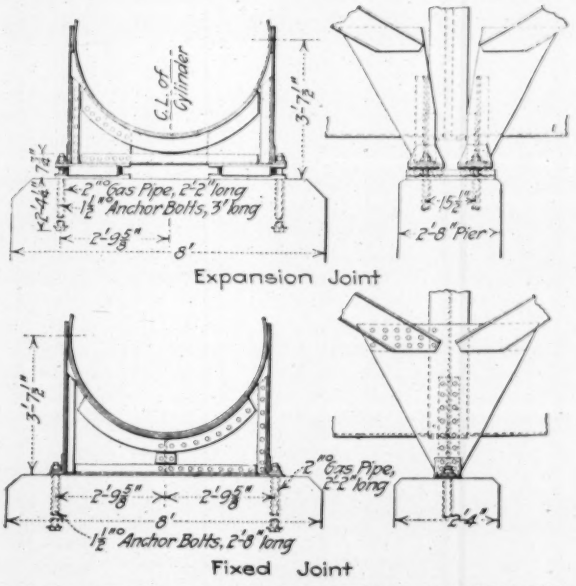
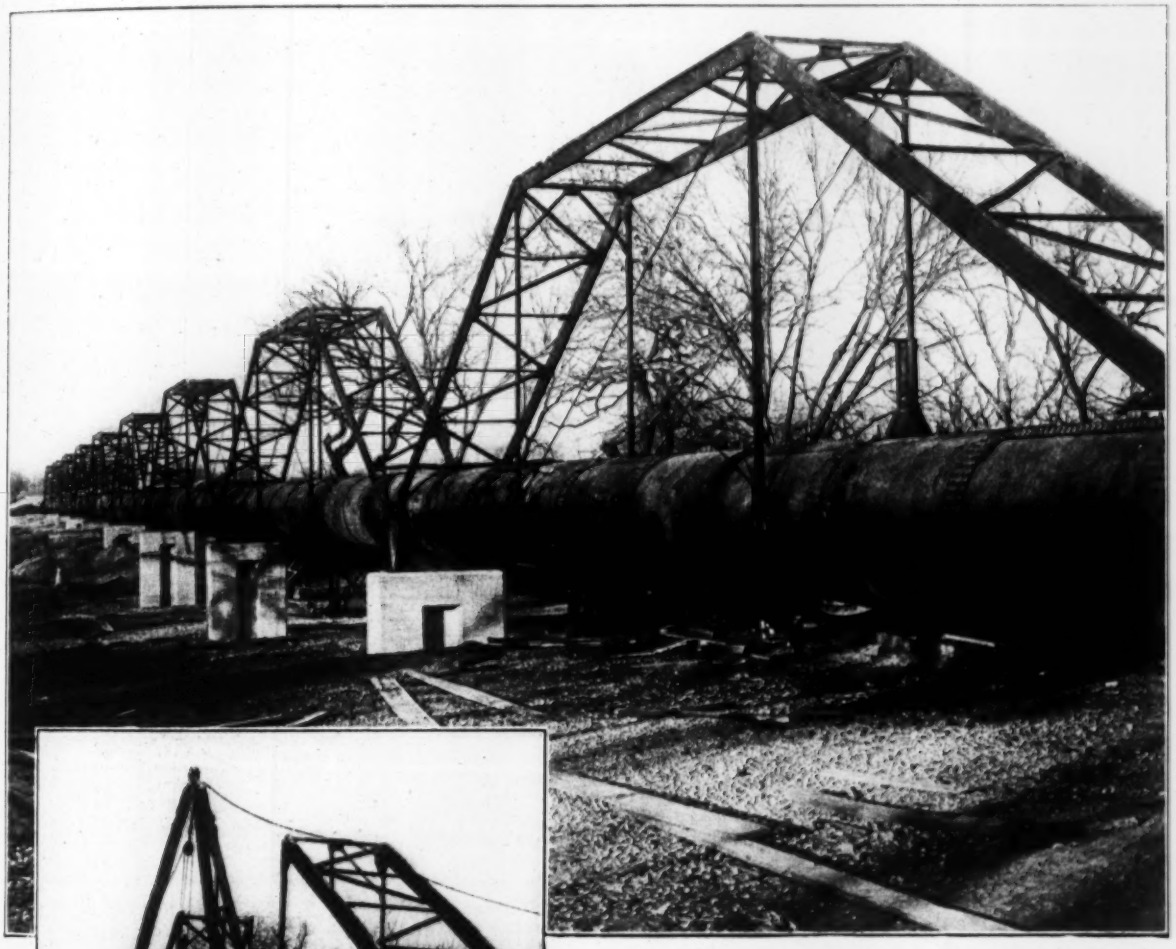


FIG. 1. FIXED AND EXPANSION ENDS OF AQUEDUCT TRUSSES FOR SAN ANTONIO SEWER

itself forms the bottom chord of the trusses. The Chicago Bridge and Iron Work built the steelwork.

Reference to Fig. 1 will give the details of the pipe connection with the concrete section. A packed sliding joint is used at these points. There is a 30-ft. span at each end, and between the ends are 18 spans of 81 ft. 10 in. each. The city engineering department designed an ingenious pier type for the support of the trussed spans, as shown in Fig. 2. The pier consists of two 3x3-ft. concrete columns set on a base plate, connected by a 12-in. diaphragm and capped at the top. The steel spans have expansion on alternate piers. A roller expansion shoe is used. As shown in the view in Fig. 2 the trussing consists of a pair of top chords each made



FIGS. 2 AND 3. SEWER AQUEDUCT COMPLETED AND DURING ERECTION

of one 10-in. 20-lb. channel. Queenpost hangers of one 3x3x⅜-in. angle and ¾-in. round turnbuckle rod diagonals (Fig. 3) give the connection of top chord to pipe. The attachment of the hangers to the pipe is made by placing a semicircular stirrup or saddle under the pipe, consisting of two 5x3½x⅜-in. angles riveted into Z-shape, to which the hanger angle is riveted. Top laterals are 2½x2x⅜-in. single-angle diagonals.

The pipe (except expansion joints) weighs 385 lb. per lin.ft. The trussing of one span weighs 6,200 lb. Since the pipe flowing full carries about 1,800 lb. of liquid per lineal foot, the total load on each span is about 180,000 lb. The chord stress is 40,500 lb. per channel, the depth of truss being about 24 ft.

M. E. Erwin is engineer of sewers, Hans Helland is city engineer, and W. H. Kearny is commissioner of streets and sewers of San Antonio.

City Planning at Cebu

By R. C. Hardman*

A few years ago the City of Cebu, Philippine Islands, was visited by two disastrous conflagrations which practically wiped out the retail business district, leaving intact but a few of the most substantial stone buildings. The work which followed in the line of replanning after the second fire presents some very remarkable features in the way in which privately owned property was handled.

Cebu is one of the oldest cities in the Islands, having been the landing place of Magellan in 1521. The streets were of the cow-path type, varying in width from the span of a man's outstretched arms to about 30 ft.

Modernizing Streets of Burned-Over Area

As the Insular government was improving the harbor to the extent of about half a million dollars, it was decided by the authorities to make an effort to modernize the burned area. One of the first steps taken was the appointing of a committee to devise ways and means. Rebuilding operations were prohibited until the report of the committee with surveys, plans, etc., was rendered.

The area burned over by the two fires was 29.1 acres, with street frontages of 15,766 ft., and as will be seen by Figs. 1 and 2, the street system and the arrangement of individual lots were complicated. The property was of course valuable. Modernizing the area meant, naturally, the straightening and widening of the streets or the location of new ones on a modern system. The only feasible rearrangement of streets was necessarily one in which practically no attention could be paid to the old lines. And obviously, any radical departure from the existing arrangement would play havoc with the prevailing ownership of property. As the work had to be done very economically if at all, no buildings of any great value could be condemned. Consequently the new streets must be governed in their location by the existing valuable buildings, as well as by the location of the adjacent and connecting streets and plazas. For this reason the main street, Calle Magallanes, was left practically the same in alignment, but with its width increased to 30 m. Similarly, the streets bounding the area were left practically as before. Within the boundaries of the area no attention was paid to existing streets or private property other than buildings, with the exception noted. A comparison between the old and new arrangements is well shown in Fig. 1, wherein all buildings are represented.

Changing Size, Shape and Location of Lots

Up to this point nothing remarkable was done, as all usage of private property could have been taken care of by condemnation. However, in the disposition of private property a very unusual method was employed. The problem next to be solved was the changing of the size and shape of each of 250 lots and refitting them into the newly established blocks. The area of the private property was 117,805 sq.m., which was to be placed within the 100,000 sq.m. available under the new arrangement. The street frontages were likewise to be reduced from 4,805.5 m. to 4,699.9 m. The reduction in area of 15.1% and the loss in frontage of 2%, furthermore, had to be accomplished without cost. A similar attempt in the United States would, without doubt, have been attended by a sharp rise in values and endless litigation.

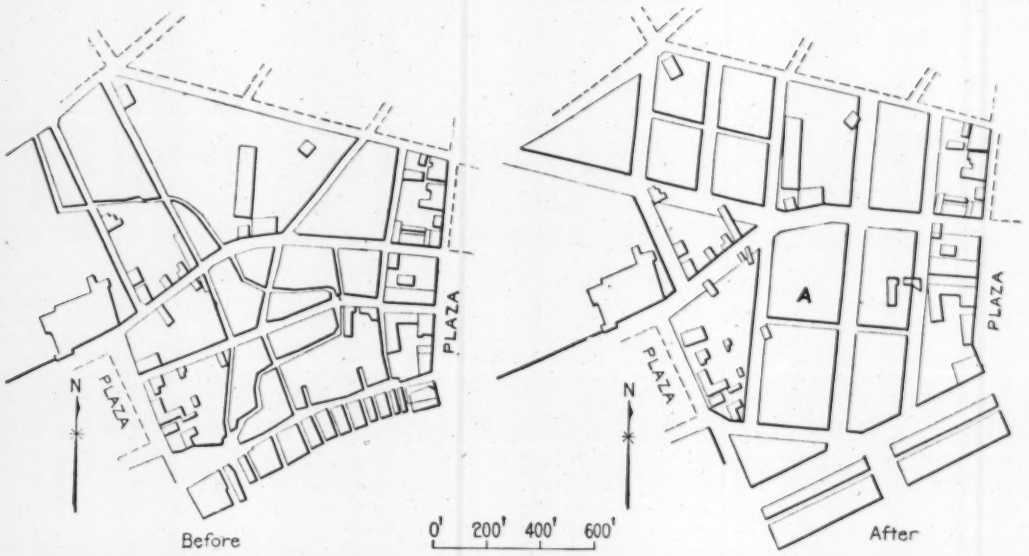


FIG. 1. REARRANGEMENT OF STREET SYSTEM IN THE CITY OF CEBU IN THE PHILIPPINES
The new streets are 15, 20, 24 and 30 m. wide

As a first step in the process the area of each lot was determined by planimeter, after being surveyed, and its frontage and *average* depth determined by scaling. Tables were prepared showing these results, with additional columns for old value, new depth and new frontage. From Fig. 2, which shows the typical arrangement of lots, it will be seen that the application of the methods employed was largely a matter of judgment in a great many cases. In other cases, such as lots entirely surrounded by other lots and lots having frontage on alleys, the method could not be applied at all.

The next step was the preparation of a table or scale of values. An arbitrary value per front foot for each successive 10 ft. in depth was assumed. Thus the first 10 ft. was assumed to have a value of $20 per front foot, the second 10 ft., $18; the third 10 ft., $16, and so on in decreasing amounts. A lot 30 ft. deep would thus have a value of $54 per front foot. The assumed values were flat, no distinction being made between the high and low real

*Colorado Springs, Colo.

values. It was further arbitrarily assumed that the wider and straight streets would enhance the value of the property by a flat 10 per cent. From these assumptions the following value scale was prepared:

Assumed Old Value	Depth in Feet	Assumed New Value
$20.00	10	$22.00
38.00	20	41.80
54.00	30	59.40
68.00	40	74.80
80.00	50	88.00
90.00	60	99.00
98.00	70	107.80
104.00	80	114.40
108.00	90	118.80
110.00	100	121.00
112.00	110	123.20
114.00	120	125.40
116.00	130	127.60

The values given are not the actual ones used, but serve to illustrate the principle involved. For depths other than shown the values were interpolated.

The value scale was used as follows: Consider an old lot 30 ft. in depth and having a frontage of 50 ft. Its value per front foot would be $54 and its total value 50 × $54, or $2,700. This particular lot is to occupy in its new location a space 80 ft. in depth. Under the "new value" heading a lot 80 ft. deep is found to have a value of $114.40 per front foot. Therefore the frontage of the new lot would be $2,700 divided by $114.40, or 23.6 ft. Its new area would be 1,888 sq.ft., as against its original area of 1,500 sq.ft. A typical table follows:

		Old				New		
Name	Lot No.	Front, Ft.	Depth, Ft.	Area, Sq.Ft.	Value	Front, Ft.	Depth, Ft.	Area, Sq.Ft.
Juan Cui....	2	26	30	780	$1,404	18.8	40	752
Pedro Cuan..	3	47	120	5,640	5,358	46.8	80	3,744
J. Bulayat...	7	8	75	600	808	7.0	80	560
Jose Cadongog	9	20	20	400	760	12.8	30	384
D.Macapugay	13	12	110	1,320	1,344	11.8	80	944
V. Leon.....	15	50	30	1,500	2,700	22.3	100	2,230

It will be seen from the table that the owner of a deep lot lost and the owner of a shallow lot gained, in area, by the readjustment. The cases mentioned are not actual ones, but merely show the method used. The only lots that remained in the same positions, approximately, were those upon which permanent buildings were situated, and these often suffered changes in area and boundaries. The majority of the lots were materially changed in location, and a number found themselves several hundred feet from their original positions. A glance at Fig. 2 will show that this must necessarily have been true, as there is absolutely no resemblance between the "Before" and "After" of the sketch. Interior lots were placed upon alley frontages in the new arrangement—the alleys, 5 m. in width, being wider than many of the old streets.

One New Lot Composed of Nine Old Ones

To have made these extremely radical changes legal in the ordinary way—that is, by the transferring of small parts of original lots to the numerous owners of the new conflicting lots—would have entailed an almost endless amount of computing of intersections, bearings, distances, etc. For instance, the lot designated *A* in Fig. 2 is made up of parcels of nine old lots. To have made the transfer would have required nine separate descriptions and maps and nine separate deeds.

In order to eliminate this work the committee in charge was empowered by an Act of the Philippine Commission to "acquire title to all lands within said area by gift, cession or transfer from present claimants of said lands, and having secured title to said lands, is empowered to make application to the Court of Land Registration to have the title of all lands within said area registered and confirmed in the name of said committee. . . . After the title to said lands shall have been registered in accordance with the preceding paragraph, the committee shall convey title to the person or persons or corporations entitled thereto in accordance with the allotments agreed upon and shown on plan filed with the application in the Court of Land Registration."

In addition to the original burned area a plat of ground being reclaimed by the harbor improvement was also platted. This area is shown in the lower right-hand corner of the "After" section of Fig. 1.

The work seems to the writer to be remarkable, not from a technical standpoint, but as an example of what appears to be high-handed juggling of private property.

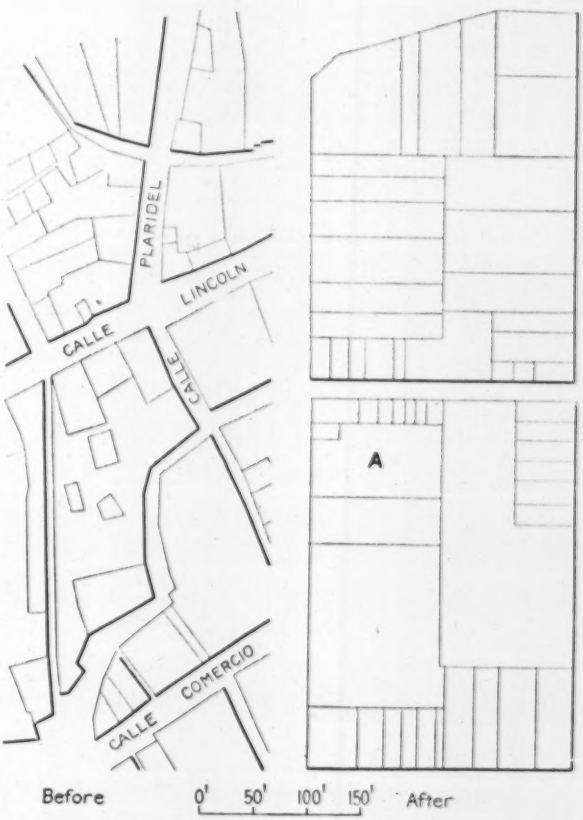


FIG. 2. REARRANGEMENT OF LOTS IN CEBU

The individual lots were changed in almost any manner that would insure their fitting into the blocks provided for them, much in the same way that a jigsaw puzzle is pieced together. In fact, small pieces of paper representing the lots were actually used. Small discrepancies in area were adjusted, or distributed, over adjacent lots. To anyone who has been engaged upon similar work in the United States, where the question of private property is such a bugbear and one of the most difficult obstacles to be overcome, the work will stand more as a problem in human nature than one of engineering.

The committee having the work in charge consisted of the Consulting Engineer to the Commission, J. W. Beardsley; the Provincial Supervisor, T. Warren Allen; the Provincial Fiscal, Sergio Osmena, and the Municipal Presidente. The work was done by R. F. Moss and the writer under the immediate direction of T. Warren Allen.

National Guard Engineer Corps

By Louis D. Koop*

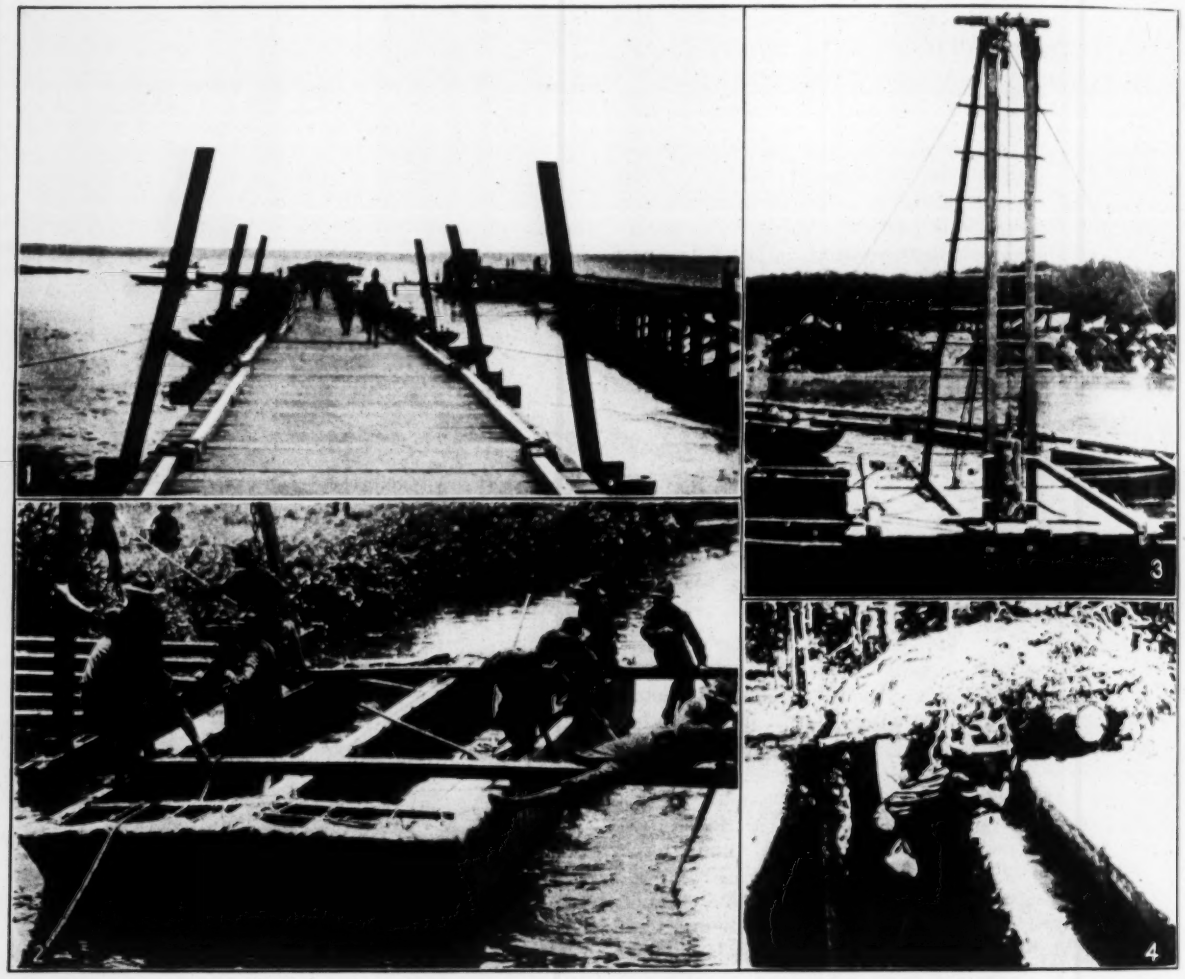
Few civilian engineers seem to be aware that there now exist in a number of the states National Guard Corps of Engineers, in which they can get the requisite training, drill and instruction to fit them for immediate service as military engineers in case of necessity. There is, however, a serious deficiency in number of companies and an opportunity to improve the situation. The following is a list of the existing organizations:

State	Station	Strength
Colorado	Golden	1 company
Illinois	Chicago	1 company
Iowa	Iowa City	1 company
Michigan	Calumet	1 company
New York	New York City	2 battalions
Ohio	Cleveland	1 battalion
Oklahoma	Norman	1 company
Pennsylvania	Scranton and Philadelphia	2 companies

The land forces of the United States are divided into the mobile army and the coast artillery. As the basis of organization of the mobile army we have the division—a self-contained unit made up of all necessary arms of the service. At war strength it consists of about 22,000 men. Several divisions may be grouped in a field army. The War Department has prepared plans for organizing the mobile troops of the regular army and the National Guard into 16 divisions, of which 12 divisions comprise the National Guard. At present there is a deficiency of 13 battalions of engineers in the National Guard divisions, there being only eight pioneer and five ponton battalions. There is thus a splendid opportunity for engineers in states having no engineer troops to form and organize units.

One pioneer battalion of engineers is attached to a division and a ponton battalion to a field army. A pioneer battalion consists of three companies. For service with infantry divisions a pioneer company is organized as follows: 1 captain, 2 first-lieutenants, 1 second-lieutenant, 1 first-sergeant, 1 quartermaster-sergeant, 12 sergeants, 18 corporals, 2 cooks, 2 musicians, 64 first-class privates and 64 second-class privates—a total of 168 officers and men.

The engineer troops of New York State as now organized consist of a pioneer battalion and a ponton battalion known as the "22nd Corps of Engineers." These troops are armed, equipped and receive the same instruction and



FIGS. 1 TO 4. ILLUSTRATING ACTIVITIES OF 22ND CORPS OF ENGINEERS, N. G. N. Y., AT BELVOIR, VA.

Fig. 1—Heavy pontoon bridge construction. Fig. 2—Building canvas pontoon bridge. Fig. 3—Floating piledriver of pontoon equipment. Fig. 4—Trench with overhead cover

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drill as the U. S. Engineers, and under the supervision of a commissioned officer of the Corps of Engineers, U. S. A., detailed as inspector-instructor, and a sergeant from the U. S. Engineers.

The armory of the 22nd Corps of Engineers is at 168th St., near Broadway, New York City, Lieut.-Col. E. W. V. Lucas, commanding. Major F. W. Whitely is in command of the pioneer battalion, and Major W. S. Conrow is in command of the ponton battalion. Capt. R. S. Thomas, Corps of Engineers, U. S. Army, is inspector-instructor. Drills are held on Thursday and Friday nights.

During the year the training drill and instruction is divided into two periods—armory instruction and field training. The armory instruction is both theoretical and practical and is given during the period between Oct. 1 and May 1. The field training is entirely practical and covers outdoor drill and instruction given at camps, maneuvers, etc., during the period between May 1 and Oct. 1. Theoretical instruction consists of lectures, quizzes and examinations, held weekly and covering all military and engineering subjects. Practical instruction is given one night a week between 8:15 and 10:30 in the following subjects:

Military—Infantry drill, military courtesy, personal hygiene, care of rifle, care of uniform and equipment, tent pitching, rolling blankets and packs, signaling, sighting and aiming drill, indoor target practice, bayonet exercise, guard duty, map maneuvers, horsemanship.

Engineering—Reconnaissance-map reading, use of sketching board, map making, topographical symbols, visibility problems, photography, map reproduction.

Field Fortifications—Model trenches (sand box); model of overhead cover, models of revetments, models of obstacles, construction of flares, construction of alarms.

Bridges—Knots and lashings, loading ponton equipment, assembling pontons, rigging tackle, constructing shears and derricks, king-post bridges, trestle bridges, pile-driver construction.

Demolition—Precaution in demolition, distinguishing explosives, splicing powder and electric fuses, computation and placing charges, construction of mines.

The work covered during the field-training season is performed at the schools of application, target ranges, camps and maneuvers. It consists of infantry drill and exercises, target practice and the construction in the field of engineering works.

In 1915 the principal field training was received by each battalion during a period of two weeks at Belvoir Tract, Va., in joint camp with two companies of U. S. Engineers. Belvoir Tract is situated on the Potomac River about 15 mi. below Washington. This site is well adapted to engineer operations, having plenty of timber, and a river bordering on the camp site suitable for instruction in ponton work. The reservation is of sufficient area to permit full sway to be given in actual practice of pioneer operation, such as digging trenches, cutting timber and executing demolitions. All of the work done at this camp consisted of practical field engineering and was pronounced by all taking part as having been one of the most instructive camps in which they had participated. The accompanying photographs show the New York engineers at work.

A provisional company from the 22nd Corps attended the state camp at Fishkill, N. Y., for a period of a month last summer, laid out the camp site, constructed the water-works, built bridges, laid out and supervised the construction of a mile of trenches by the infantry, constructed land mines and dismantled the water-works. In this work the engineers were thrown on their own initiative and acquired valuable experience in cooperating with other arms of the service and gave an impression as to the true rôle of engineers.

From this it will be seen that the kind of men who are best qualified for this work and who should join engineer organizations are engineers, both field and office men, construction superintendents, and foremen and mechanics, such as carpenters, dock-builders, timbermen, riggers, iron workers and railroad men. It should also be understood that military engineers are soldiers first and engineers afterward. A large number of the officers and men of the 22nd Corps are practicing civil, mechanical and electrical engineers.

In New York men enlist for three years and are required to attend drills one night a week between October and May and to attend the field training camp for about two weeks in the summer. All arms, uniforms, etc., are furnished free of charge, and during the two weeks of field training, transportation, rations and all necessities are provided, with pay at a minimum rate of $1.25 a day for enlisted men. If a man is unexpectedly required to leave the city in which his company is located, he may be dropped or discharged and taken up again when he comes back, receiving credit for his previous service.

The training in punctuality, order and businesslike methods that are required in military service will make a man more valuable in civil life. There is everything to gain and nothing to lose by joining the National Guard.

California Has a Reserve Corps of Military Engineers

A general plan of organization has been perfected that provides for a "Civilian Volunteer Reserve Brigade of Engineers for California," to be officered and instructed by specially qualified engineers and retired United States engineer officers. There is to be one officer of the Army Engineer Corps as advisory head. The state has been divided into three sections, and one regiment of eight companies is provided for each section between Eureka and San Diego. These companies will have senior- and junior-grade engineers (civil, mechanical, electrical, mining and chemical) as commissioned and noncommissioned officers. General instruction in military engineering and infantry tactics will be given the officers preparatory to recruiting for the enlisted grade, which grade will not be recruited at present. This will remain a civilian-engineer organization prepared to volunteer its services in case of need. Training will not interfere with private business and will follow, as much as possible, instructions as approved by United States Army engineer officers. During the coming year, at least, resignations will be accepted promptly in case it is found advisable to give up the work.

Company headquarters have been made and recruiting officers appointed for San Francisco, Sacramento, Grass Valley, Eureka, Oakland, Berkeley, Alameda, Palo Alto, San José, Stockton, Merced, Fresno, Bakersfield, San Luis Obispo, Santa Barbara, Los Angeles, Santa Ana, Riverside and San Diego. The provisional colonels are W. C. Hamatt and G. L. Dillman, of San Francisco, and C. T. Leeds, of Los Angeles. J. D. Swedberg, of Oakland, is brigade adjutant.

Lessons in Road Maintenance from New York State

By T. M. Ripley*

SYNOPSIS—These comments on road construction and maintenance are the result of a continued personal discussion between the editors and Mr. Ripley, who has had unusual opportunities to study both natural and abnormal deterioration of New York State roads. Changed conditions are described which have caused once-approved construction to become inadequate. Methods of construction and maintenance have been developed which lead to a reasonable certainty of success—provided ample funds are made available.

It is possible that the prevalence of complaints in some sections of New York State may be due to roads which are in so poor condition that they cannot be properly repaired without the expenditure of more money than is at the disposal of the Highway Department. This would be the case where the roads had been improperly built for the traffic now going over them, and where they had deteriorated so rapidly that the lighter methods of maintenance would not keep them in condition.

In dealing with this subject of road maintenance in New York, we must bear in mind that maintenance as handled today, is of comparatively recent origin, having been carried on along any definite lines, for only about three years, while many of the roads are from six to sixteen years old.

For a number of years these earlier roads were subjected to practically nothing but horse-drawn traffic, and their deterioration was comparatively slow. During the last few years this traffic has almost entirely changed. Although some of the horse-drawn traffic yet remains, the volume of the traffic is to a large degree made up of motor vehicles, ranging from motorcycles to heavy trucks, and in place of the horse-drawn vehicle, which traveled at a speed of from 3 to 8 mi. per hr., greater loads now travel at a speed of from 10 to 40 mi. per hr.

The Automobile Dominates

The advent of the high-speed automobile has further demanded a smoothness of surface that was never dreamed of with the horse-drawn vehicle, or with the slow-moving motor vehicle. The proof of this as between the horse-drawn vehicle and the motor vehicle is not necessary. For proof as between the slow-moving and the swift-moving motor vehicle, all that is necessary is to move over a piece of improved highway that is not in perfect condition, at 10 or 15 mi. per hr., or even at times as high as 20 mi. per hr., and then with the same machine move over this same road at from 35 to 40 mi. per hr. Inequalities in the road which merely give one a slight rocking sensation at the slower speed become disagreeable or dangerous bumps at the higher speeds.

To determine in the most accurate manner what is the cause of the present condition of some of these older roads would require information that could be secured only from men who are personally familiar with these roads since their completion as construction contracts. As it is practically impossible to interview these men, it is necessary to assume the conditions from our knowledge of road construction and maintenance; our knowledge of general traffic conditions as outlined; of the appropriations made by the state for maintenance in the past years; and from the fact, as before stated, that maintenance along really definite lines has been in existence for a comparatively short period. These assumptions may best be presented in a description of a hypothetical case.

Let us assume a waterbound road constructed of two courses of broken stone, the bottom course 3 or 4 in. thick and the top course 2 or 3 in. after being compacted—the road costing about $1 per sq.yd. of pavement. For the sake of our study either one of these types will answer, as these are the earlier road types. Assume that the bottom course was filled with fine material but not puddled. The top course was filled with fine material and puddled. This top-course filler was in practically all cases a selected material, and one of the objects to be secured in puddling it was to get it as nearly waterproof as possible. Such a road was opened to horse-drawn traffic. At either end of this road, which varied in length anywhere from a fraction of a mile to 7 or 8 mi., the old road conditions obtained. This hypothetical improved stretch was the best piece of road the users had ever seen outside of a city or large incorporated village, and everyone who had to use the highway of which this improved road was a part was pleased with it.

How a Good Road Became Inadequate

If a few raveled spots appeared in the road they were given little attention; the traffic and the rains many times healed these spots, as there were no swiftly moving vehicles to throw the loose stone off the road before this healing action could take place. But in some instances these spots did not heal. Nevertheless, it was a small amount of fine loose stone on a hard foundation, being gradually ground finer and finer by the traffic and offered little or no obstruction to the movement of the horse-drawn vehicles. Maintenance was scarcely thought of. The years went on. The horse-drawn traffic continued, and the wear of the road increased. In fact, whether it was a 2-in. or a 3-in. top, in many cases the surface was worn entirely off in spots, some of these spots extending quite a distance along the road. This after the passage of several years.

The automobile was then appearing as a factor, and now and then a complaint was made about the road being rough—these complaints coming not from the old slow-moving traffic, but from what we may call the new medium-speed traffic. In place of the man and his buggy, or the family and its carriage, we had a few automobiles moving, let us say, at 15 to 20 mi. per hr. and weighing a ton. While even then the auto had not become a controlling factor in our transportation problem, yet the road was obviously inadequate for the new conditions. Such a running review brings us up to about 1905.

In two or three years more the automobile had increased greatly in numbers, and it was determined that some

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more positive binder must be used to hold the top course of the roads together. So in 1907 and 1908 we find bituminous material being used as a binder in the construction of a portion of the state highways, and about this time or soon after, the cry was raised that the roads were being built for the automobilist.

Three or four years more passed, and the cry became a reality. We were building roads for the automobile owner, because the automobile had become the most numerous vehicle on the highways. More and more of the new roads were being bound with bituminous material, the only binder at that time known, which would meet the conditions. The type of road had materially changed. It is still changing today. In place of the bottom or 3 or 4 in. of broken stone, we are building with 6 in. or more of larger stone, and the top is either bound with bituminous material or waterbound and bituminous application put onto the latter as soon as possible; or else a more expensive type, such as concrete or brick, is put in place of the entire stone body. The costs have jumped up to some $1.50 per sq.yd. for the bituminous carpeted road, $1.50 for the cement concrete, $2.50 for the bituminous concrete, and to $2.70 for brick[1].

The construction of a bituminous top required entirely different treatment than did the waterbound top, and engineers and contractors were both ignorant as to the methods required. It took several years to learn the most essential points in the construction of a maintenance top, in order that the road might be smooth when completed—and even today this desirable condition is not always obtained.

Maintenance Question Arises

The maintenance of the roads constructed prior to 1908 and those in the years immediately following was left almost entirely to patrolmen who were appointed because of the political ticket that they voted. The energies of the Highway Department were devoted almost exclusively to the construction of new roads and an effort so to build them that the traffic conditions could be met and criticism stilled. Looking back from the present, it seems almost certain that the engineers of six and eight years ago did not conceive what would be the traffic conditions of today, or else conditions which they could not control prevented doing the work that they desired. From year to year, as the maintenance question was brought more forcibly to the attention of the people, it was passed by in the belief that it would be met providentially in some manner or other; the department lived from year to year, with the ever-present hope that enough money would be appropriated to put the roads in proper condition, although each year without proper maintenance made the situation more nearly impossible.

No one, excepting a person familiar with the situation, realized that these older roads, numbering about six hundred, besides many of the later ones, would have to be practically rebuilt so far as their metal was concerned, or entirely resurfaced in order to give the highway demanded by the automobile of later date.

Therefore, in regard to the "earlier roads," with which it seems conservative to place those built prior to 1910 or 1911, their present condition in the majority of cases can be attributed to improper design for the present traffic, to lack of knowledge of the necessity for maintenance, and finally to a lack of money to cover that necessity provided it had been recognized.

Aside from the earlier roads mentioned, there have been many hundreds of contracts, aggregating two thousand miles or more of improved highways, which can go into what might be called "later construction"—and "construction" as here used means both the design and the physical action of building the road.

Maintenance and Recent Construction

In regard to the maintenance of these later roads, their present poor condition is due first to the fact that it had not been clearly recognized that maintenance must start as soon as the road is opened for traffic, and that *some definite surface treatment must be given to a macadam road, whether waterbound or bituminous, not later than two years from the date of its completion*, if this road is to be kept in good condition.

Secondly, in the earlier part of this latter stage the men in charge of construction had nothing whatever to do with the maintenance, and it was looked upon as a side issue. Although it was handled by the general department, nevertheless few of the men cared to be associated with it. The roads were scattered over the entire state, some of them in almost inaccessible places, and the man in charge of a district had an extremely large territory. He was appointed because of his political friends, and to take a day's journey to look at four or five miles of country road could readily be construed as a waste of energy.

Although it was reported that other states had smooth and beautiful roads, nevertheless it was not considered of enough value to the state to pay the expenses of its employees to go and examine these roads, and for the first few years the work of maintenance seems to have drifted along without any definite port in view or any rudder to guide it. This condition has been entirely changed within the last two or three years.

Today the maintenance is under the same corps of men as is the construction, and the same men in the field are held responsible for the maintenance of their roads as for the building of the new ones. Fairly definite ideas have been formed as to the treatment of different types of roads, and efforts are made by the department to secure the money necessary to carry out these ideas. There is probably no executive officer in the department today, who has authority over the field work, but who knows practically what these definite ideas are, even to the men in imme-

[1] Two hundred and forty-two waterbound roads built between 1898 and 1908 of two 3-in. courses of broken stone cost per square yard of pavement $1.05, or per square yard of roadway $0.63; 61 waterbound roads built between 1910 and 1915 with 6 in. of foundation stone and 3 in. of top stone cost per square yard of pavement $1.29, or per square yard of roadway $0.76; 126 bituminous state highways built between 1911 and 1915 cost per square yard of pavement $1.42, or per square yard of roadway $0.81; 130 bituminous county highways built between 1911 and 1915 cost per square yard of pavement $1.48, or per square yard of roadway $0.79. The average cost of brick roads built prior to 1915 was $2.67 per sq.yd. of pavement, or $1.48 per sq.yd. of roadway. The cost of concrete roads prior to 1915 was $1.40 per sq.yd. of pavement, or $0.72 per sq.yd. of roadway. The average cost of bitulithic roads prior to this date (1915) was $2.42 per sq.yd. of pavement, or $2.26 per sq.yd. of roadway. In all of the preceding figures the total cost of the road has been divided by the square yards of pavement actually laid for the first cost shown and divided by the total square yards in the highway between the ditch lines for the second cost, the distance between ditches being taken at a theoretical elevation, as shown on the standard plans. The two costs given for bitulithic are more nearly alike than the similar two costs for any other pavement; this is because a very small portion of bitulithic was built outside of city or village streets, where the entire width of the roadway was paved. The foregoing costs show an increase during the last few years of construction. This is due primarily to the heavier roads that were constructed in this latter period.

diate charge in the field. Moreover, these field men have had from one to three years' experience and there is no excuse, except the lack of funds, why the roads should not be in condition to carry the present automobile traffic.

From the reasons immediately before stated, *it is a fact that the question of successful maintenance today rests upon the money available and the willingness of the men to work* more than upon any physical characteristic of the roads.

Organization of Maintenance

The physical maintenance can be divided roughly into two classes—heavy and light. Heavy maintenance is that work which requires a more or less complex organization and plant and would include the reconstruction and resurfacing of roads, the widening of the macadam, etc. This heavier maintenance costs from $3,000 to $6,000 per mi. and results in constructing a new wearing surface for the road, besides strengthening weak places by putting in new foundation, etc. The report of Fred W. Sarr, Second Deputy Highway Commissioner to the Hon. Edwin Duffey, Commissioner, dated Jan. 1, 1916, states that during the year 1915 the average cost of resurfacing and reconstruction on about 5% of the total mileage of improved highways was $5,500 per mi., which, figured on the basis of a 16-ft. bituminous-macadam road, would be equal to about 60c. per sq.yd.

The lighter work consists of patching, cleaning the ditches and shoulders and applying the lighter asphalt compounds. This work takes a much less complex organization, both of men and machinery. Moreover, this latter class of maintenance can be done, and is usually done, while traffic is going over the road, while the former maintenance practically requires the closing of the road. The cost of this lighter maintenance is divided between the patrol as now organized, maintenance gangs, and contract or day labor for putting on the light asphalt.

The heavier class of maintenance can probably better be done by contract, but the lighter class can better be done by departmental forces. Much of it is and always has been so done, particularly the cleaning of the shoulders and ditches and the minor patching, which is taken care of by the patrolmen. In the last few years the patrol situation has greatly improved, as the patrolmen have been put under the division offices and have been given to understand that their position depends upon the quality of their work as well as upon their politics.

Owing to the increase in the mileage of bituminous roads during the last few years and to the further fact that it has been demonstrated that an application of light bituminous material applied about every two years was the most efficacious maintenance therefor, there has developed a practically new line of work commonly known as "cold oiling." This is a simple operation requiring no organization that cannot be procured in the neighborhood, and a comparatively simple plant layout.

The time at which this application is made is important not only for the best interests of the physical road, but also for the traveling public. Moreover, in a great majority of cases a road does not need an equal application over its entire length, and therefore the application should be frequently varied. These two elements of time and variable quantity of material applied, coupled with the simplicity of the operation, make it a class of maintenance that can best be handled by the department.

The cost of "cold oiling," like the cost of the heavier class of maintenance before mentioned, varies through quite wide limits, owing to the many factors that enter therein. With local covering material handy and easy to obtain, this work can be done as low as 3c. per sq.yd. On the other hand, where the cover for the bituminous material, or cold oil, has to be shipped long distances by rail or some other items are expensive, the cost can easily become 5c. per sq.yd.

Owing to numerous legal complications, as well as other causes, light maintenance by the department has not been developed as economy would warrant. Such expansion would entail close and detailed application on the part of much of the organization, and the development of an executive ability which, along certain lines, is now practically dormant under the contract system.

Effect of Weather

The deterioration not due to wear, as well as the wear of the traffic itself upon the road, is prevented and compensated for in a very large measure, on macadam roads, both waterbound and bituminous, by the application of the light bituminous material noted, particularly as on all of these applications there is spread a thin wearing or blotter course of sand, fine, clean stone, gravel, iron-ore tailings, or some similar material, which takes the first wear of the traffic.

It is believed that the physical factors that cause deterioration (aside from normal wear) are principally frost and the deterioration of the bituminous binder. In some portions of the state the frost action at times is extremely severe, particularly upon roads that have not proper subdrainage. Roads have been "blown up" by frost to such an extent that had a rooter plough gone through them, they could not have been in much worse condition. Such effects as these can be remedied only by practical reconstruction.

The deterioration due to the reduction in the binding quality of the bituminous material can, in a large measure, be offset by the lighter application above mentioned.

Interurban Motor Busses

There is another factor that is becoming more and more persistent, which in the natural progress of events shortly may be included in normal wear, but which has in the past been considered to give abnormal deterioration. This is the operation of motor-vehicle lines for hire between villages and cities, running upon a schedule. These vehicles operate at all seasons of the year when they are able to traverse the road. Although the ordinary automobile traffic is heaviest in the summer and fall, when the roads are in the best condition to support it, this auto-vehicle traffic operates when the roads are soft from frost in the spring and when they are alternately freezing and thawing in the fall. In many portions of the state they are a serious menace to the integrity of the improved highways.

There are other abnormal conditions which are only local in effect and which scarcely need be considered here, such as particular factory districts and mining districts. Such districts as these, from the engineering side, demand special treatment in design, but frequently this is impossible owing to the fact that many other interests besides those of the engineer have the ability to control the design, through the power to regulate the money available.

Roads are being extensively constructed and successfully maintained over which automobiles can be operated with comfort and safety at the higher rates of speed earlier referred to. So to construct these roads means giving them a better wearing surface than was contemplated 15 years ago; more diligent and careful maintenance is essential. I have in mind a stretch of road 150 mi. long, over which we went into many different counties, driving with perfect ease and safety at an average speed of 30 mi. per hr. The condition of this road is due to the fact that the men in charge are constantly watching it and doing what their funds will permit to keep it in proper repair.

It may be well to say something here in regard to the man who knows how to drive. This is the man who understands his machine and obeys the law. He is the man who can, in the country where the road is clear and smooth, and with a so-called high-power car, make the hills at the same speed that he travels upon the level; he slows down for the villages and doubtful traffic; he takes advantage of the good road and saves his machine on the bad road. Existence of such a class of drivers is not a theory but a fact; I have seen men who would travel the distance noted at the speed indicated, and yet at no time with the clearest and best road in the country did they exceed 35 to 37 mi. per hr., cutting their speed down as low as 15 and 20 mi. per hr. in the villages. Such a driver with a clear road will travel at from 30 to 33 mi. per hr. up hill and down for hours at a time, where one who does not understand his machine thoroughly will be operating it at better than 40 mi. per hr. to make the same average speed. It is these higher rates of speed which demand the smoother road and which cause many of the criticisms that come. It is these extreme rates of speed which require the better-bound roads.

Methods of Stream Gaging

By W. S. Pardoe*

There are a few points regarding approximate methods of stream gaging which are not at present presented with any degree of clarity in textbooks devoted to this subject.

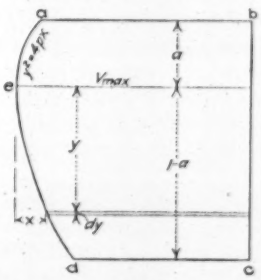
If a large number of velocity measurements be made at varying depths in a stream and these velocities plotted, the resulting curve can be closely approximated by a parabola with axis horizontal at the point of highest velocity, varying values of the parameter (*latus rectum*) being used to give the correct curvature. The following discussion depends on this fact.

The area inclosed by *abcde* is proportional to the discharge in a section

$$dA = \left[V_{max} - \frac{y^2}{4P}\right] dy$$

$$A = \left[V_{max}\, y - \frac{y^3}{3(4P)}\right]_{-(1-a)}^{a}$$

$$= V_{max} - \frac{1 - 3a + 3a^2}{3\,(4P)}$$



This is also equal to the mean velocity, as bc = unity.

Let y_1, y_2 and y_3 be the depth of measurements made in approximate methods:

1. One-Point Method—0.6 depth.

$$V_{max} - \frac{(y_1 - a)^2}{4P} = V_{max} - \frac{1 - 3a + 3a^2}{3\,(4P)}$$

or

$$y_1^2 - 2y_1 a + a - \tfrac{1}{3} = 0$$

It is evident that the only value of y which will satisfy this equation is

$$y_1 = a + \sqrt{a^2 - a + \tfrac{1}{3}}$$

As a varies from zero to 0.5, it is evident that the one-point method gives only very approximate results.

2. Two-Point Method—0.2 and 0.8 depth.

$$\frac{V_{max} - \frac{(a - y_1)^2}{4P} + V_{max} - \frac{(y_2 - a)^2}{4P}}{2}$$

$$= V_{max} - \frac{1 - 3a + 3a^2}{3\,(4P)}$$

or

$$2_3 - 2a + 2a\,(y_1 + y_2) - y_1^2 - y_2^2 = 0$$

$y_1 = 0.2$ and $y_2 = 0.8$ very nearly satisfy this equation and eliminate the effect of variations in a, which is most desirable; $y_1 = 0.21$ and $y_2 = 0.79$ will give slightly more accurate results.

3. Three-Point Method—0.2, 0.6 and 0.8 depth.

$$\frac{3V_{max} - \frac{(a - y_1)^2}{4P} - \frac{(y_2 - a)^2}{4P} - \frac{(y_3 - a)^2}{4P}}{3}$$

$$= V_{max} - \frac{1 - 3a + 3a^2}{3\,(4P)}$$

or

$$1 - 3a + 2a\,(y_1 + y_2 + y_3) - y_1^2 - y_2^2 - y_3^2 = 0$$

It is evident that $y_1 = 0.2$, $y_2 = 0.6$ and $y_3 = 0.8$ do not satisfy this equation and do not eliminate the effect of variation in a; $y_1 = 0.15$, $y_2 = 0.5$ and $y_3 = 0.85$ eliminate a and satisfy the equation.

The points I have tried to bring out are: (1) The one-point method (0.6 depth) is only very approximate, but will be correct for $a = 0.15$. (2) The two-point method (0.2 and 0.8 depth) is very nearly theoretically correct and gives correct results (see table in Hoyt and Grover); also that 0.21 and 0.79 depth would be a little more nearly correct. (3) The three-point method (0.2, 0.6 and 0.8 depth) is not as accurate as the two-point method, which is corroborated by the previously mentioned table. If the three-point method is to be used, I would suggest 0.15, 0.5 and 0.85 depth. (4) If the mean of *(n)* points is to equal the mean velocity in a vertical, the points should be selected to eliminate *(a)* and satisfy the following equation

$$\frac{n}{3} - na + 2a\,(y_1 + y_2 + y_3 + -y_n) - y_1^2 - y_2^2 - y_3^2 - y_n^2 = 0$$

Heating Standard for Gas—The Public Service Commission for the First District, State of New York, is about to establish stations in all boroughs of the city for the purpose of testing the heating value of gas supplied by the gas companies in this district. The law at present requires the testing of gas as to its illuminating power only. While the law requires a standard of 22 cp. for gas supplied in the first district, the value of such a standard is questioned at the present time, when comparatively few open-flame burners are used, when mantle lamps are extensively employed and when gas is used largely for heating, cooking and power purposes.

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†This equation is put in somewhat different form in "River Discharge," by Hoyt and Grover.

Memphis Flood Protection

SYNOPSIS—Rising flood levels in the Mississippi River made necessary the protection from inundation of a low-lying tract in the City of Memphis. A levee with concrete core wall has been built in front of this tract, and a pumping station lifts the water draining from the territory back of the levee when the river is in flood. Water draining from higher elevations, which would otherwise flow to the pumping station, is intercepted and discharged to the river through two large tunnels driven through soft ground with considerable difficulty.

The City of Memphis, Tenn., has nearly completed extensive works to make the city secure against damage by high water in the Mississippi River. During the Mississippi floods of 1912 and 1913 the newspaper reports gave the impression that a large part of the city was inundated by the high water in the Mississippi. Fortunately for Memphis, this was not the case. Most of the city stands on the high bluffs that bound the Mississippi on the west and are at an elevation of 150 to 200 ft. above low-water mark in the river.

Prior to the year 1900 no flood in the Mississippi ever caused any damage in Memphis. About that time, however, the extension of the levees protecting the St. Francis basin on the west bank of the Mississippi prevented the flood waters of that stream from overflowing an area of land some 50 mi. wide to the west of the river, and it became evident that flood levels in Memphis were to be much higher in the future than in the past.

In 1903 the Mississippi at Memphis reached a stage of 40 ft. above low water, and some lands in the northern part of the city lying along the banks of the Bayou Gayoso were flooded. This bayou is a small dry creek that rises in the southern part of the city and discharges near its northern boundary. In order to protect the property along the lower regions of the bayou from being overflowed, levees were built along the lower course of the stream at an elevation to withstand the backwater from a flood of 41 ft. in the Mississippi.

This system gave satisfactory protection until 1912, when at the time of the floods which devastated Ohio the Ohio River rose to an unprecedented stage and it became evident that all previous flood heights at Memphis would be exceeded. Rush work was begun, raising the levees along Bayou Gayoso and they successfully held the water until a stage of 42 ft. was reached, when they broke and the land back of them was overflowed. The Mississippi rose to a stage of 45½ ft. and would have gone to 48 ft. at least, had not the levees protecting the Arkansas bottom lands on the west side of the river broken and allowed the flood waters to discharge there.

It was seen that to protect the flooded area from future damage a different plan would have to be adopted. While some urged that the conditions in 1912 were unprecedented and need never be expected again, action was hastened by a recurrence of the flood in 1913, when the river reached a stage of 46½ ft. It was determined, after careful consideration, that in order to make the low-lying lands in North Memphis safe against overflow, a flood of 50-ft. stage in the Mississippi must be guarded against.

The Board of Commissioners of Memphis instructed the City Engineer, J. H. Weatherford, to prepare plans for flood protection.

Three different plans were studied. The first plan proposed the raising of all streets in the flooded area to an elevation that would bring them above a 50-ft flood. The second plan was for the building of a complete system of storm sewers throughout the entire city, with pumps to discharge the storm water falling below the 50-ft. contour during seasons of high flood. Both these plans were found to involve a cost greater than was justified. The plan finally adopted may be readily understood by examination of the accompanying sketch map (Fig. 1). It involves, first, a levee along the river front near the outlet of Bayou Gayoso, protecting the land along its lower course from overflow by back water; second, the diversion of the flow in the upper reaches of the bayou into the river by gravity; and, third, at the mouth of the bayou a pumping station capable of discharging the remaining flow in that stream into the river in time of flood, as well as the sanitary sewage and storm water from the low-lying section.

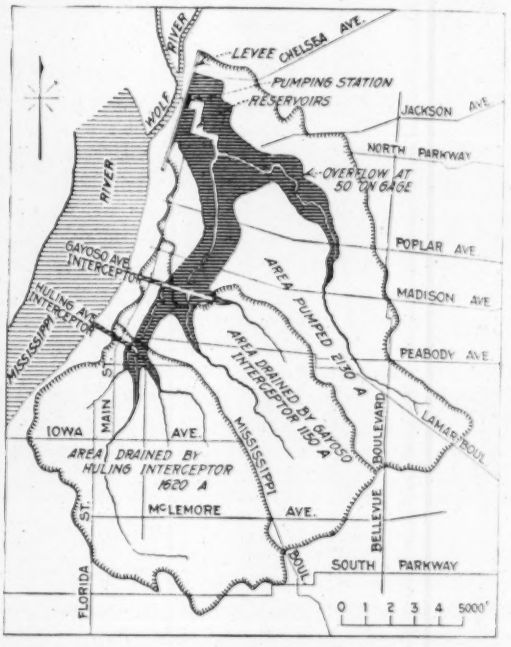

FIG. 1. SKETCH MAP OF FLOOD-PROTECTION SYSTEM, MEMPHIS, TENN.

A levee about 6,000 ft. long was built along the river front to prevent backwater from the river entering the valley of Bayou Gayoso. The levee has a minimum top width of 40 ft. with side slopes of 3 on 1. For a considerable distance it was necessary to avoid the land damage resulting from the slope of the levee on the land side. Here a concrete retaining wall with vertical face was built for a distance of 2,380 lin.ft. This wall has a face 10 to 12 in. thick, is 14 to 26 ft. in height and is held erect by tension counterforts 12 in. thick. The crest of the levee was placed at an elevation of 52.5 ft.

The site of the levee was covered with a deposit 3 to 15 ft. deep of cinders, bark and slabs. Under this were

strata of river silt, quicksand, clay, etc., as shown on the accompanying section (Fig. 2). A line of 35-lb. United States steel sheet piling was driven through the soft material into a hard blue clay at a depth of 35 to 50 ft. The piles were driven with a 2,500-lb. drop hammer. Concrete walls were built on top of these steel sheet piles; and where the core wall was built inside the earth levee, an extra-long steel pile was left every 9 ft., extending up above the other piles to a height of 46 ft. on the gage, or 6 ft. below the top of the levee; 540 ft. of core wall of this type was constructed. The steel piling cost $29.84 per ton, and the cost of hauling and driving was 9.9c. per sq.ft.

The city furnished and drove the sheet piling, did the stripping and built the concrete walls. The earth filling in the levee, amounting to about 200,000 cu.yd., was done by the Illinois Central R.R., which will occupy the top of the levee with its tracks.

The Pumping Station

The entire drainage area of Bayou Gayoso is 4,900 acres, but 2,770 acres in the upper part of this area was drained by gravity to the river through two intercepting tunnels as shown in Fig. 1. This left an area of 2,130 acres tributary to the pumping station. It should be understood, however, that it is only necessary to pump the flow from this area during periods of high flood. At all ordinary times the flow of the bayou will discharge into the river by gravity. Further, to reduce the time during which pumping will be necessary, the old levees along the bayou were retained, so that it is not necessary to begin pumping until a stage of 40 ft. is reached in the river. This also reduces the pumping lift, since it is not necessary to lower the level of the water in the bayou below 35 ft.

From a careful study of rainfall records it was determined to fix the maximum runoff on the area drained at 4,160 cu.ft. per sec., equivalent to a discharge at a rate of 2 in. of rainfall per hour all appearing as runoff. The chance is so small, however, that such a period of maximum rainfall will coincide with a period of maximum flood that it was deemed sufficient to take the rainfall at 1½ in., or a runoff of 3,120 cu.ft. per sec. To reduce still further the necessary capacity of the pumping station, certain areas of low-lying land of little value along the valley of the bayou were purchased for use as storage reservoirs. By storing the peak of the flood in these reservoirs the pumping station does not need to be of so large capacity. It was finally designed for 1,200 cu.ft. per sec.

Besides the water flowing down the bayou, it was necessary to drain the lowland behind the bayou levees. A storm sewer was built through this territory, discharging at the pumping station. A large part of the city's sanitary sewage is discharged into the river at this location through a 48-in. main sewer. Water begins to back up in this main sewer when the river gage reaches 34 ft. To provide for this situation, a bypass has been constructed where this main sewer intersects the storm

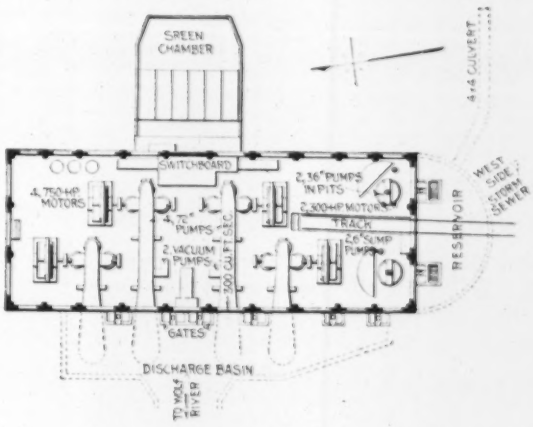

FIG. 3. PLAN OF PUMPING STATION

sewer previously referred to, so that the sanitary sewer may be discharged into the storm sewer at times of flood, backflow from the river being prevented by flood gates in the sanitary sewer. The discharge through this storm sewer, which has to be taken care of at all times of high water or for a period of two months more or less in the average year, is handled by separate low-level pumps in the drainage pumping station, with a capacity of 160 cu.ft. per sec.

The pumping station is founded on 1,200 creosoted yellow-pine piles driven through the soft material to the hard blue clay below. On the heads of these piles rests a concrete floor 3½ ft. thick, with its top surface 6½ ft. above low-water mark (Fig. 4). This floor carries the pumping machinery and the walls of the building. The west wall, which forms a part of the levee, is 5 ft. thick at the base, reducing to 2 ft. thick at 52 ft. elevation. Under this wall, as under other parts of the concrete levee wall, interlocking steel sheet piling was driven through the soft material to the impervious blue clay below. This concrete wall is pierced by four openings 7½x10 ft., controlled by rectangular sluice gates. These gates are closed only during flood periods in the river; at all other times they are open to permit the water in the bayou to flow into the river by gravity.

At an elevation of 36 ft. above the foundation floor is a reinforced-concrete floor of the beam and girder type, supporting the machinery. This floor is carried by concrete columns from the foundation floor, and these columns are braced near the middle of their height by concrete struts. The building is 60x 160 ft. long, and its outside walls are of concrete to an elevation of 52. Above this, concrete pilasters are carried up to support the crane girders, with curtain walls of red brick between. Steel trusses support the roof, which is of 3-in. concrete-slab construction reinforced with ⅜-in. rods spaced 6 in. apart, with longitudinal rods spaced 24 in. apart, the concrete being

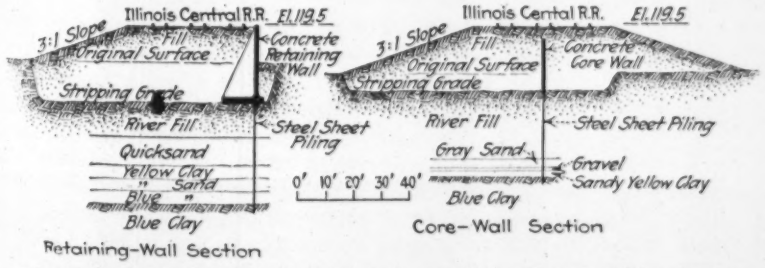

FIG. 2. SECTIONS OF LEVEE ALONG RIVER FRONT AT NORTH MEMPHIS

covered with Carey composition roofing. The foundation concrete was mixed with river run sand and gravel as aggregate, five sacks of cement being used to 1 cu.yd. The reinforced concrete in the superstructure was made with crushed limestone as the aggregate, six sacks of cement to ½ yd. of sand and 1 yd. of crushed stone (1 : 2½ : 5).

The main pumping plant, which is of 1,200 cu.ft. per sec. capacity, is operated when the river is at stages of 40 ft. or higher and when the flow in the bayou is such as to require its operation. The low-level pumping plant, which is of 160 cu.ft. capacity, is operated when the river is at 34 ft. or higher. The head against the pumps varies of course with the stage of water in the river. The main plant is designed for a maximum head of 15 ft., the low-level plant for a maximum head of 25 ft.

The main pumping plant consists of four 72-in. centrifugal pumps mounted on horizontal shafts and each driven by a direct-connected 750-hp. 3-phase 50-cycle, 6,250-volt slip-ring induction motor, with a normal speed of 116 r.p.m. The pumps are set on the machinery floor, high above the normal water level. To put them in operation the motor is started under no load, the pump runner revolving in air. When the pump is running at speed, vacuum pumps are started, which exhaust air from the pump chamber and as it fills with water, the pump begins operation. To prime the pumps in this way there is a battery of two Connersville rotary vacuum pumps of 400 cu.ft. per min. free-air capacity. Each pump is connected by a silent-chain drive to a 20-hp. electric motor.

There are no valves whatever on the pipes leading to and from the pump. It will be evident, therefore, that the pump chamber acts as a siphon. In case of failure of the current and stoppage of the pump at a time when it is lifting water into the river there would be a prompt reversal of the flow through the pump, and a huge stream would be discharged back into the bayou under a head due to the difference in the level of the water inside and outside. To prevent this reversal of flow, the pump is provided with an automatic vacuum breaker. [illegible] as the current supplied to the motor is cut off, whether purposely or by accident, a 6-in. valve is automatically opened, permitting air to flow back into the top of the pump chamber, so that the back flow of water through the siphon will be prevented before the pump has actually ceased to turn.

At the south end of the building is a circular pump well 20 ft. in diameter containing two 36-in. vertical-

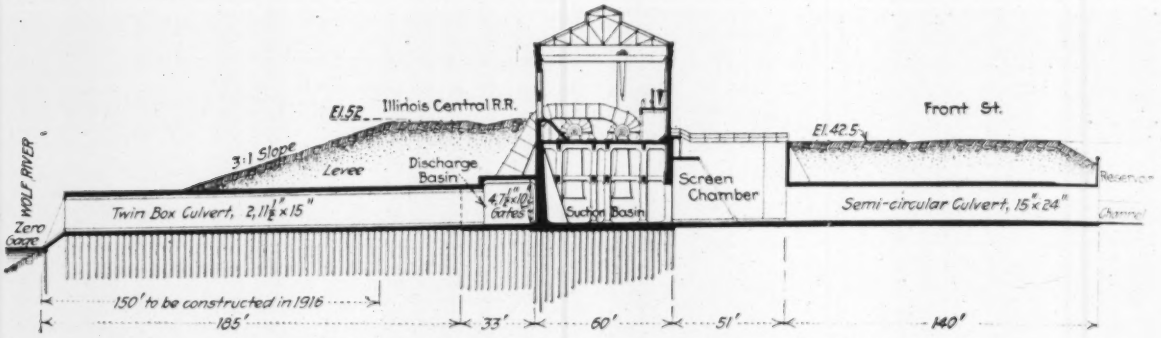

FIG. 4. CROSS-SECTION THROUGH PUMPING STATION

shaft centrifugal pumps of 80 cu.ft. per sec. capacity, each driven by a 300-hp. 6,150-volt induction motor at 165 r.p.m. As already explained, these pumps handle the flow of sanitary sewage and the storm-sewer discharge from the low district and greatly reduce the time during which it is necessary to operate the large pumps.

To protect the pumps from obstruction a screen chamber 40 ft. wide is located on the east side of the building, in which is placed an inclined rack 30 ft. high and 40 ft. wide. Suitable screens also protect the low-level centrifugal pumps.

Power for operating the pumps is supplied by the Memphis Consolidated Gas and Electric Co. by a special contract, under which it agrees to keep sufficient reserve power available for operation of the station at all times. A duplicate transmission line from the power station to the pumping station, about 3 mi. long, has been installed, of which 2½ mi. is underground. The pumping station was erected by the James Alexander Construction Co., Memphis; the pumps and motors were installed by the Allis-Chalmers Manufacturing Co.

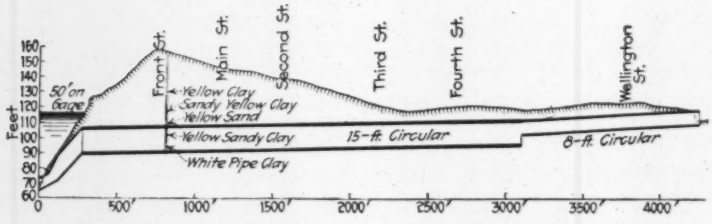

FIG. 5. PROFILE OF GAYOSO AVE. TUNNEL

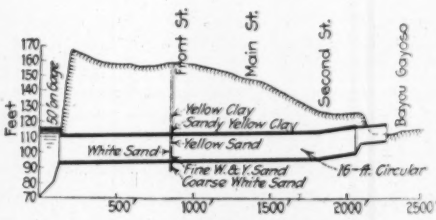

FIG. 6. PROFILE OF HULING AVE. TUNNEL

As shown on the sketch map, Fig. 1, the Huling Ave. tunnel is designed to intercept the drainage from 1,620 acres near the head of Gayoso Bayou. The tunnel (Fig. 6) is of circular section, 16 ft. in diameter, and extends eastward from the river 1,925 ft. At the river end it has an outlet apron or spillway 125 ft. long. The 16-ft. tunnel is fed by an 8-ft. circular branch 830 ft. long, a 9x10-ft. rectangular branch, 125 ft. long and an 8x11-ft. rectangular channel about 2,900 ft. long. The 16-ft.

circular sewer is lined with monolithic concrete 22 in. thick, the lower one-third of the section being faced with vitrified brick, to stand erosion. About 1,700 ft. of this structure was built in tunnel and the remainder in open cut.

The tunneling work was especially noteworthy because of the difficulties encountered. For a considerable distance the depth of cover over the tunnel is about 55 ft.

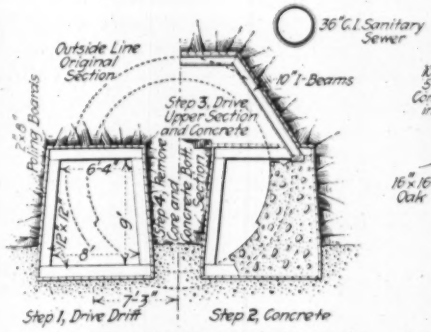

FIG. 7. SECTION ILLUSTRATING SECOND METHOD OF OPERATION IN DRIVING HULING AVE. TUNNEL

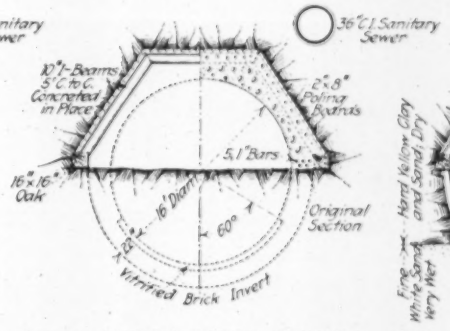

FIG. 8. CROSS-SECTION SHOWING THIRD METHOD OF DRIVING HULING AVE. TUNNEL

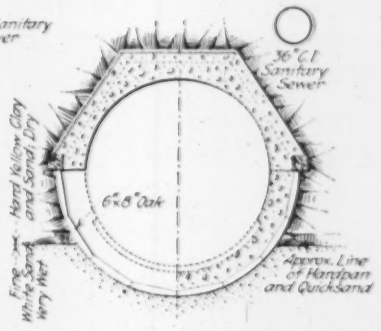

FIG. 10. CROSS-SECTION SHOWING METHOD OF COMPLETING LINING OF HULING AVE. TUNNEL

The tunnel was directly under the line of the street above. On account of the buildings along the street it was necessary to use great care not to cause settlement in the work of excavation. Work was started at the river end with a circular steel shield 21 ft. in diameter and 9 ft. long, driven forward by 16 hydraulic jacks. The original plan was to line the tunnel with oak segments 4 ft. long, 6x8 in. in section, for the jacks to push against. Inside this wooden lining the concrete lining was to be placed according to the general method carried out in the Dorchester tunnel under Fort Point channel, Boston, described in *Engineering News* of Jan. 20, 1916.

The shield was built at a local boiler shop and weighed complete about 16 tons. Its skin was made up of $\frac{5}{8}$-in. plates with lap joints and the three successive rings of plates were joined by telescopic joints, so that the diameter of the shield at the cutting edge was about $2\frac{1}{2}$ in. greater than the diameter at the tail. Inside the cylinder thus formed were placed eighteen 6-in. I-beams running longitudinally and bolted to the skin of the shield. These I-beams were 3 ft. long and were placed 18 in. back of the cutting edge of the shield with their rear ends 5 ft. in front of the tail. A 4x4x$\frac{3}{8}$-in. angle bent to a circle was riveted to the skin at the front and rear of these longitudinal beams, and the 18 jacks used to shove the shield bore against the rear angle. A pair of 12-in. channels riveted together back to back was bent to circular form and placed inside the longitudinal beams, and there were two working platforms. There was no other interior bracing and it will be seen from the above that for 18 in. back from the cutting edge and for 5 ft. in front of the tail there was no bracing whatever for the skin of the shield.

This shield was forced forward by 18 hydraulic jacks of 5 in. diameter, supposed to operate under 3,000 to 5,000 lb. pressure; but when the movement of the shield was too slow, the safety valve and automatic stop on the hydraulic pumps were removed and the pressure raised to 8,000 lb. per sq.in.

After the shield had been driven forward about 75 ft. the overload from the jacks and the pressure of the superincumbent earth, about 50 ft. in depth, so distorted the shield that work was stopped. The top of the shield was bent in about a foot, and the working platforms were crumpled up.

Plans for repairing and reinforcing the shield were made by C. H. Hollingsworth, superintendent for the contractors, and some six weeks were spent in this work. In order to do this it was necessary to excavate the material overlying the shield, and timber around the shield so that it was entirely exposed. In rebuilding, only the skin of the old shield was used. In this was placed an entirely new system of interior bracing containing 46,000 lb. of steel.

Experience proved, however, that it would have been better to have replaced the outer skin as well, for when the rebuilt shield was again started the $\frac{5}{8}$-in. shell plates showed a tendency to bend and buckle on striking the slightest obstruction. The shield was forced forward, however, until 560 ft. of tunnel had been completed. The shield then failed so completely that it was decided to abandon this method of tunneling entirely.

The contractor then attempted to drive the tunnel forward by the method illustrated in Fig. 7. Two rectangular drifts 10x11 ft. in size were driven forward on each side, leaving the material between and above them undisturbed. Inside these drifts concrete was placed for the haunches of the arch. Then a top drift was carried forward large enough to include the upper half of the arch ring, the timbering supporting this drift footing on the concrete already placed. Inside this drift the upper half of the lining was built, and to complete the tunnel the core of earth at the bottom was removed and the invert was closed.

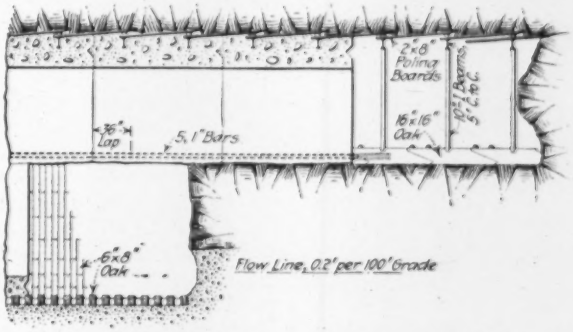

FIG. 9. LONGITUDINAL SECTION ILLUSTRATING THIRD METHOD OF DRIVING HULING AVE. TUNNEL

This method was enormously expensive for the contractor, since he was placing double the quantity of concrete he received pay for and was removing a considerable excess of earth for which he received no compensation. In addition to this the methods used left voids at the junction of the side drifts and the top drifts and the leakage of air was so great that it proved impossible to hold sufficient air pressure to keep back the water in the lower sand strata. These difficulties increased so rapidly that the contractor was again shut down after making only 385 ft. additional and required to submit still another method.

Final Method on Huling Ave. Tunnel

The new method, which may be termed a flying arch method, was authorized since the arch could be built entirely in a hard sandy clay strata entirely above the water-bearing sand. It seemed probable, also, that air pressure could be dispensed with, but this was not done, the work being carried on under from 5 to 10 lb. of air.

The method used was to drive a top drift with poling boards supported by 10 in. standard I-beams 5 ft. centers as in the previous section, the beams ordered for that work being used; these beams resting on 16x16-in. oak blocks having a net length of 5 ft. as shown in Figs. 8, 9 and 10. After drifting about 50 ft. ahead, a section of form was placed and the arch concreted; five 1-in. reinforcing rods were placed as shown at the external lower edge of the side walls.

The top drift was driven and concreted the remaining 730 ft. before any further work was done on the bottom. On completion of the arch a section about 15 ft. long immediately adjoining the end of the completed invert was excavated and lined with the oak cants, which had been purchased for use with the shield, the water being held back by the air pressure. Ten feet of this section was then lined with concrete and 10 ft. additional was then excavated, and lined and so on.

All this tunneling work was done under compressed air at 5 to 9 lb. pressure. The voids back of the lining were filled with grout, and so thoroughly was the grouting done that in some cases the grout was forced upward until it appeared on the street surface. The contractor for this work was the Southern Asphalt and Construction Co. The contract price, which included the portion built in open cut, was $230,000.

The Gayoso Ave. Tunnel

The Gayoso Ave. tunnel drains 1,150 acres below the area intercepted by the Huling Ave. outlet. The tunnel (Fig. 5) has 275 ft. of outlet section of special form, 2,805 ft. of 15-ft. circular section, 1,155 ft. of 8-ft. circular section, an 11½-ft. section 420 ft. long and a 6-ft. rectangular branch 570 ft. long. The whole work was built by Thomas-Hammond & Hickey Brothers Co., the contract price being $218,000. The 15-ft. tunnel is lined with monolithic concrete 20 in. thick, where built in tunnel, and reinforced-concrete 12 in. thick in open cuts.

The circular tunnel section was lined with 20 in. of concrete and was built by the shield method, using wood lagging or cants. The shield was 19 ft. 10 in. outside and 9 ft. long—the outer shield being of ¾-in. plates, stiffened by two ¾-in. annular plate ribs and angle irons and had an interior cylindrical lining about 16 ft. in diameter and 4½ ft. long leaving a 36-in. tail shield and and 18-in. cutting edge. There was one horizontal platform on the center line of the shield. This shield was forced forward by 16 Watson-Stillman hydraulic jacks 7½-in. diameter and 24-in. stroke under about 2,500 to 5,000 lb. water pressure. The jacks pushed against the lining of 6x4-in. cants about 4 ft. long with their outer surface cut to a 9 ft. 10 in. radius. The cants were placed from the bottom upward; the two cants at the top were set by placing one end of each against the other cants of the ring with the other ends together and forcing these ends back with a jack. The cants were laid to break joints and were ordinarily spiked to the next ring back to hold them, but were so firmly interlocked by the pressure against them as to render them extremely rigid when in place. The cants compressed under pressure about 10%, 10 ft. of wood making approximately 9 ft. of lining. Pine, gum and oak were used in the order named, the pine failing utterly and the gum being abandoned in favor of the oak.

Occasional trouble was had from the lining breaking under the jack pressure, making it very hard to keep the shield on line and grade; but after placing, no settlement could be detected by measurement of the sides or roof, though the shield was at one time 200 ft. in advance of the concrete lining.

Excavation was pushed continuously with three 8-hr. shifts, being discontinued ordinarily only during concreting. Progress averaged about 5 ft. for each 8-hr. shift, and including all delays averaged 10 ft. per day.

The material encountered was a hard clay varying to a hard, sandy clay for the top two-thirds and a fine, water-bearing sand for the lower one-third. Practically the entire length of tunnel was built under air pressure of 5 to 10 lb. All excavation and materials, except concrete, were hauled with one electric locomotive, using current from overhead trolley, and were locked into and out of the tunnel. A single track line with turnouts was used.

Mixing and Placing Concrete

The concrete in both these tunnels and in the connecting works was made of river run sand and gravel dredged from the Mississippi, five sacks of cement being used to 1 cu.yd. of sand and gravel for monolithic concrete and six sacks per cubic yard for reinforced concrete. Vitrified-shale paving brick was selected for the brick lining.

The concrete for the tunnel lining was put in place by the pneumatic method, with a machine made by the Concrete Mixing and Placing Co., Chicago. With this apparatus concrete was delivered through an 8-in. pipe as far as 600 ft. from the mixer. When this distance was reached, the mixer, which was placed in the tunnel, was moved up near the working face and a 10-in. shaft was sunk from the street surface into the tunnel. Materials in the proper proportion for a batch were placed in a lock on the street surface, and the air pressure was then admitted. The bottom door of the lock was opened, and the materials dropped through the 10-in. shaft into the mixer. The proper amount of water was added in the mixer, and the concrete was blown through the 8-in. pipe directly into the forms and there spread by hand. Blaw steel forms were used almost exclusively on the work.

Acknowledgment is made to J. H. Weatherford, City Engineer of Memphis, for the information and drawings from which this article has been prepared.

Grade-Crossing Elimination by Relocations

Two excellent examples of grade-crossing elimination on country roads by relocation of the highway in one case and the swapping of rights-of-way between county and railway in another are found in El Paso County, Colorado, of which C. O. Ford, Colorado Springs, is County Engineer. Both show hearty coöperation between railway company and public authorities for the mutual advantage of all concerned.

The first case is on the Ute Pass Road from Colorado Springs west. This is a section of one of the most notable cross-country tourist routes. The trail and highway are of ancient origin and of course antedated the railway. The railway, coming through a narrow cañon, crossed and recrossed the highway a number of times, some of these crossings being very dangerous because of projecting bluffs that hid the approaching trains from the view of people on the road.

A serious accident, in which several motor-car tourists were killed, led the county and railway authorities to set about the elimination of two of the worst of these crossings. It was found that by reconstructing a mile of road, two bad railway and four stream crossings could be avoided.

This relocation required some heavy grading, a section of which consisted essentially of widening the railway grade to include the highway. This section of the work was put into a separate contract, and the railway company (Colorado Midland) was the low bidder. This grading was very economically done by a steam shovel working from the railway tracks. The rest of the mile section was let to Ripley & Leslie, General Contractors, Pueblo, Colo. The total cost was $14,000, but the county engineer estimates that this sum is less than would have been required to reconstruct and maintain the four bridges on the old road.

FIG. 1. COLORADO MIDLAND RY. BUILDING HIGHWAY AS A CONTRACTOR

The other example of grade-crossing elimination in which the Denver & Rio Grande R.R. and the county

FIG. 2. UTE PASS HIGHWAY CONSTRUCTION, EL PASO COUNTY, COLO.

swapped rights-of-way is north of the station at Fountain, Colo. Here the original county road crossed the railway twice in half a mile. The south crossing was situated on a grade and surrounded by other conditions that rendered it unsafe. A recent accident, as before, aroused the authorities to action. The proximity of substantial residence buildings made it impracticable to relocate the highway west of the railway. It was found, however, that both crossings could be eliminated by moving the railway easterly, a change that would also improve the railway alignment without changing its gradient. The county commissioners offered to furnish a new 65-ft. right-of-way and bear one half the expense of reconstruction of both railway and highway, if the railway company would swap rights-of-way. This was accordingly done, although it required a large amount of red tape, for the railway right-of-way was encumbered with four mortgages. The railway company was represented by A. O. Ridgway, Assistant Chief Engineer. Fig. 2 shows some of the relocation in progress.

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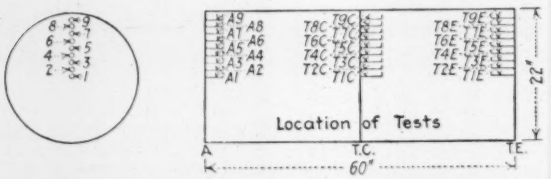
Oil Quenching Improves Solid Nickel-Steel Forgings

By C. J. Yarnall*

During the recent manufacture of nickel-steel forgings for the Quebec Bridge important questions about the effect of the oil quenching were raised. There were serious doubts as to how deep the quenching effect extends, since the forgings in question were solid forgings. In ordinary practice large forgings that must be quenched are made hollow, so that both the inside and the outside are reached directly by the oil. It was feared that in the present case there would be little or no effect in the interior of the solid forging. Whether the metal was made more homogeneous by the oil quenching was another point needing investigation.

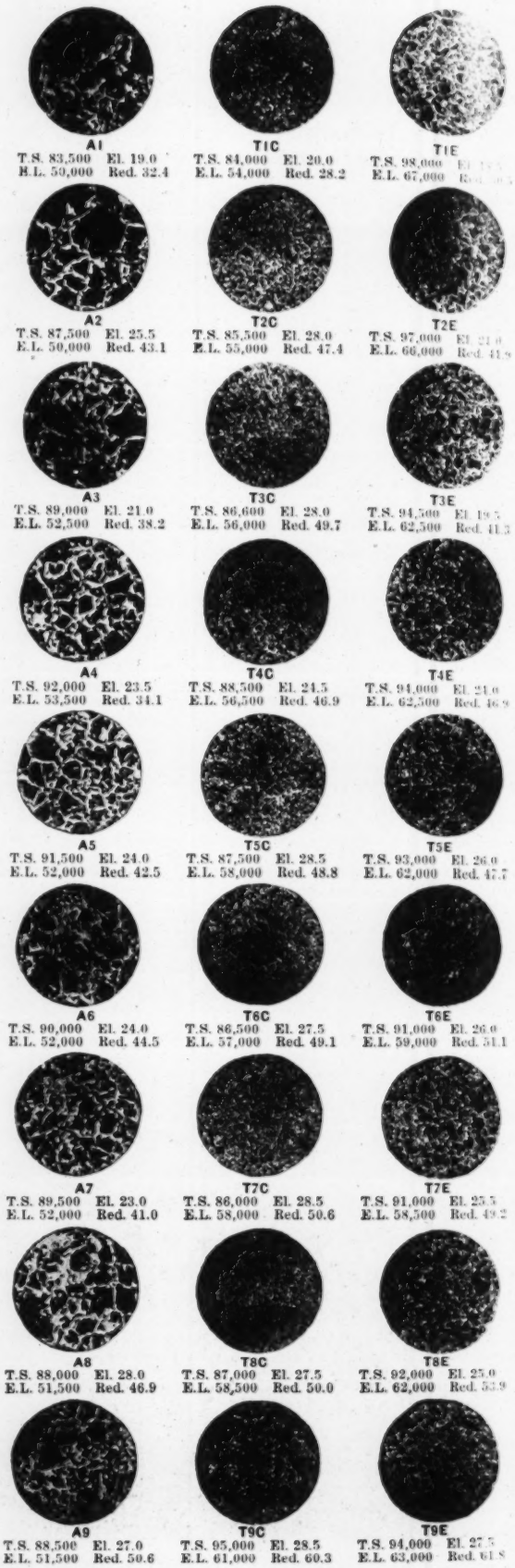
Finally, the old question of internal stresses produced by quenching was raised, and it was desired to find out whether anything in the way of internal stresses could be detected. It has always been claimed that hardening or quenching is bound to set up internal stresses due to the inequalities of contraction between the skin and the deeper-lying portions. While most persons believe that such stresses are relieved by drawing back—that is, reheating the quenched piece to a lower temperature than the previous heating and allowing it to cool slowly—there has not been enough experience with solid nickel-steel



Steel forging 22 in. diameter, forged from a 40-in. corrugated ingot. Ladle analysis: C 0.346%, Mn 0.63%, P 0.012%, S 0.031%, Si 0.050%, Ni 3.49%.
Tests A—After annealing at 1,600°.
Tests TC—After oil-treating at 1,450° and reannealing to 1,100°, middle of length of forging.
Tests TE—Same treatment, end of forging.

INTERNAL STRUCTURE OF OIL-TREATED SOLID NICKEL-STEEL FORGING (× 100)

Microphotographs of test-pieces located as shown by sketch. Threaded end of each tensile-test bar



*Chief Mill Inspector, Board of Engineers, Quebec Bridge Commission, Munhall, Penn.

forgings to make this point certain. Tests were made to try to settle these questions.

The piece selected for experiment was cut out from the middle of the forging (in order to avoid any segregation), squared at both ends to insure uniform treatment, placed in an annealing furnace, brought up to 1,600° F.

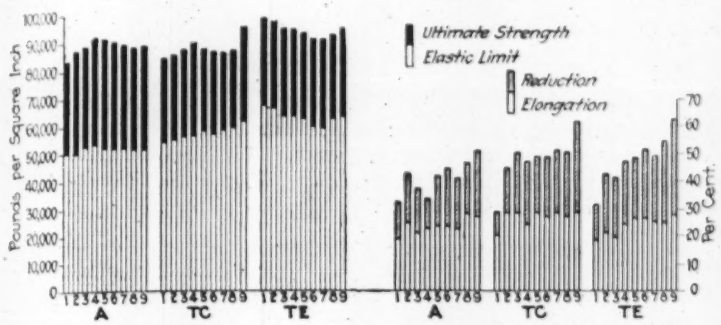


DIAGRAM SHOWING TENSILE STRENGTH, ELONGATION AND REDUCTION OF TEST SPECIMENS

and allowed to cool, then reheated to 1,100° F. At one end of the piece nine test specimens were cut out, marked *A*1 to *A*9, the letter *A* indicating "annealed" and the numbering 1 to 9 progressing from center to outside.

After these specimens were cut out, the forging was again placed in the furnace and heated to 1,450° F., immersed in oil at 85° F. and allowed to remain for 1½ hr., after which it was placed in the furnace and drawn back to 1,100° F. Then a series of test pieces was cut from the opposite end from which the annealed test pieces had been cut and marked *T*1*E* to *T*9*E*, meaning "treated forging," "end," specimen 1 to 9. Then the forging was cut at mid-length and a similar series of test pieces taken here, marked *T*1*C* to *T*9*C*.

All test pieces were slotted out in a solid block and then cut out on a shaping machine into sections 1 in. square by 4 in. long. This method guarded against distorting the pieces, as is sometimes done where a hollow drill is used and the pieces are bent back and forth until they break out. The specimens were turned to 2 in. between shoulders by ½ in. diameter and threaded both ends. Tensile tests were made on an Emery machine.

TABLE 1. CHECK ANALYSES OF NICKEL-STEEL FORGING

Carbon	Manganese	Phosphorus	Sulphur	Silicon	Nickel
		Ladle Analysis			
0.34	0.63	0.012	0.031	0.050	3.49
		Average Check Analyses After Annealing			
0.339	0.624	0.007	0.022	0.039	3.18
		Average Check Analyses After Treating			
0.372	0.73	0.010	0.034	0.044	4.58

Table 2 shows the strength and ductility figures obtained in the tensile tests.

TABLE 2. MECHANICAL TESTS OF NICKEL-STEEL FORGINGS (AVERAGES)

Ultimate, per Sq.In.	Elastic, per Sq.In.	Elongation, %	Reduction, %
	Annealed, End		
88,833	51,660	33.7	41.5
	Treated, Middle		
87,400	57,111	26.8	47.9
	Treated, End		
93,833	62,500	23.7	47.1

After the tests the threaded ends of the pieces were cut off for the microphotographs.

Chemical analyses were made of the steel in its different stages. They are summarized in Table 1 herewith. The ladle analysis of carbon is 0.346; the average of the check analyses from the nine samples from the end after annealing, 0.339; and from the opposite end after oil treating, 0.374. As the check analyses of the treated steel are all high, it cannot be said that any carbon absorption is shown. It might just as well be said that the metal absorbs manganese—which is not true, of course—as the ladle analysis is 0.63, one check analysis is 0.62 and the other 0.73. In fact, the high figures for the treated steel are a matter of personal equation on the part of the chemist.

Higher ultimate strength, elastic limit, elongation and reduction are obtained from the oil-quenched than from the annealed material, as shown by the table.

The improvement in microstructure is graphically portrayed by the series of photographs shown herewith, revealing in all cases, even at the center of the specimen, a remarkable increase in fineness of grain as compared with the coarse grain of the annealed specimen. It is evident that the heat-treatment makes the material more homogeneous and the ferrite and pearlite more intimately united. In the photographs the white areas are ferrite and the dark areas pearlite.

One of the engineers who was connected with these tests has expressed the following tentative conclusion: While there is no indication of any internal stresses in the one forging, there is a possibility of such stresses developing in another one, if a number of specimens from different heats and of different composition are subjected to the same tests.

Concrete Pavement Experience, Grand Junction, Colo.

It is quite rare to find concrete street pavements in the Rocky Mountain States, due, it is claimed, to the high price of cement in that section.

Grand Junction, Colo., is notable as having perhaps a greater yardage of concrete pavement than any other city so located. With the exception of a few asphalt-paved streets all the pavements are concrete. These were laid five years ago by inexperienced city day labor, but on the whole results have been quite satisfactory. The mistake was made in some of the earlier work of putting in contraction joints as close as 16 ft. In subsequent work the distance was made 25 or 30 ft. Most of the pavement slabs show some cracking, although rarely serious.

Various surfaces were tried—plain, scored in transverse lines about 8 in. apart and scored in crossed lines forming squares about 8 in. on a side. The former city engineer, E. R. Romberg, states that there has been no apparent advantage in the scored surface, and that it has had the disadvantage of increasing the wear from abrasion. It has had, however, one advantage in causing the cracks in many instances to follow the regular lines of the score marks and make them less noticeable and inconvenient.

The pavements are 7 in. thick at the crown, made of machine-mixed 1:2:4 concrete. They were laid in two courses, the 1¾-in. wearing surface being a 1:3 mortar.

There are about 50,000 sq.yd. in all and the average cost was $1.95 per sq.yd. The maintenance cost (filling cracks with asphalt) has been about $250 a year for the last two years only. Single course 5-in. alley pavements of 1:4 gravel concrete have cost $1.30 per sq.yd.

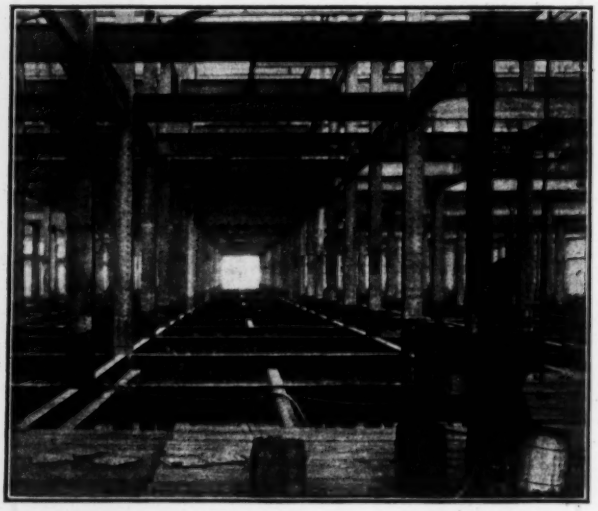
Field and Office

Temporary Flooring in Steel Buildings During Erection

The structural-safety law of Illinois provides for temporary flooring in steel-frame structures during erection. The accompanying view shows this flooring as used in the new Chicago freight house of the Pennsylvania Lines. It consists of panels of 20x22 ft. made with 2x10-in. planks 16 ft. long, laid on 6x8-in. joists of straight-grained Norway pine. The joists are 22 ft. long, laid on top of the steel beams and spaced 7½ ft. apart. The view shows only a part of the flooring in place, but the law requires the entire area to be covered.

In buildings where the height of the first two stories does not exceed 32 ft. the second floor is the first one to be covered or floored. In the freight station, however, the height is 43 ft. to the second-floor framing (24 and 19 ft. for the first and second stories respectively), and therefore it was necessary to cover the first-floor framing also. This building is 745x420 ft., four stories high, and contains about 18,000 tons of steel. The Kelly-Atkinson Construction Co., of Chicago, has the contract for its erection.

The Illinois law requires safe scaffolds not less than 16 ft. below point of work (particularly when the work is at a height of 32 ft. or more), to prevent workmen

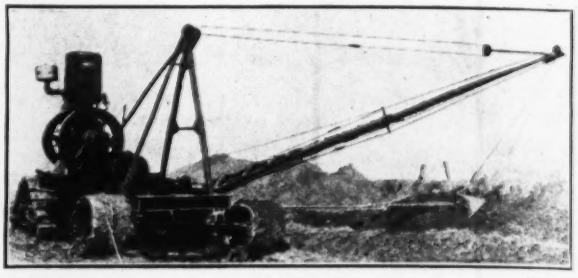


TEMPORARY ERECTION FLOORING FOR STEEL BUILDINGS, AS REQUIRED BY THE ILLINOIS SAFETY LAW

from falling in case of accident. It also requires safe temporary flooring on each story as the building progresses and not more than two stories below the level at which work is being done. The entire space must be floored, with the exception of openings for stairways, material hoists and elevator shafts. Supervision of such work, to see that the requirements of the safety law are fulfilled, is under the direction of the Illinois Department of Factory Inspection, which has its office in Chicago.

Caterpillar Backfiller for Trench Work

The trench backfilling machine shown in the accompanying view is of the dragline type and is mounted on caterpillars of a novel design. It requires only one operator. He has the four controlling levers grouped close to his seat, with a steering wheel at his right (or on the



BACKFILLER WITH CATERPILLARS AND TELESCOPIC BOOM

opposite side from the trench) and a brake treadle at his feet.

The boom has special features in being telescopic (so that it can be varied in length without dismantling) and in being swiveled so that it can be set at any angle in a horizontal plane or set parallel with the frame when the machine is traveling. Its maximum length is 23½ ft., and it has a telescopic movement of 7 ft. The heel section of the boom is composed of a pair of channels braced together, while the two outer (telescoping) sections are of pipe, stiffened by four truss rods. The boom suspension cable is led over the A-frame to a small drum on the main frame; this is operated by a worm gear, which automatically locks the drum at any position of the boom.

The 10-hp. gasoline engine drives the hoist and drag drums through chains, spur gears and friction clutches. It drives the propelling mechanism also through a chain and spur gear, with bevel-gear reverse. The main clutch, on the engine shaft, is of the multiple-disk type; this has no tendency to stick and permits instantaneous connection and release. The cable drums are 8 in. diameter, with 15-in. frictions, and are provided with eccentric-throw cone-clutches. These clutches are leather-lined and have ball-bearing thrust collars. The cables are ¼-in. for the drag, 7/16-in. for the hoist and ⅜-in. for the boom suspension, with speeds of 95 ft. per min. for the drag and 115 ft. for the hoist. The scraper can handle about four loads per minute. The traveling speed of the machine is about 1½ m.p.h.

The hauling line is guided to the drum by horizontal and vertical rollers, to control any slack in the cable, while rollers in the housing of the boom sheave prevent the hoisting cable from leaving the sheave in case of a side pull. The dragline drum is set beneath the main frame, so that when hauling the scraper the overturning effect, even in making a heavy pull, is very slight. The scraper is a flat panel, with the line hitched to a bail and the

hoisting line attached to a yoke. Large handles on the rear enable a man to guide it if necessary, as when handling sticky or heavy material.

The main frame and A-frame are of steel and are mounted on wide-tired wheels or wheels and caterpillars, as desired. The latter are triangular in form (as shown) and have a length of 4½ ft. and a height of 2½ ft., with 18-in. width of platform. The front wheels are 24 in. diameter, with 15-in. face, a rib on the center of the face giving a grip in soft ground. Where caterpillars are not used, there are rear wheels of 30-in. diameter and 18-in. face. A brake, operated by a treadle, is provided on the traction gear. This is an important feature, as it puts the machine under control on steep grades or when being run on and off cars by means of inclines.

The machine is 10½ ft. long over all (9½ ft. with wheels instead of caterpillars), 7½ ft. wide and 9 ft. high. The weight is 8,000 lb. with caterpillars, or 6,400 lb. with front wheels. A smaller machine, with 5-hp. engine and requiring two men to operate it, weighs about 2,500 lb. These machines are built by the Parsons Co., of Newton, Iowa.

Excavator for Wide Cuts

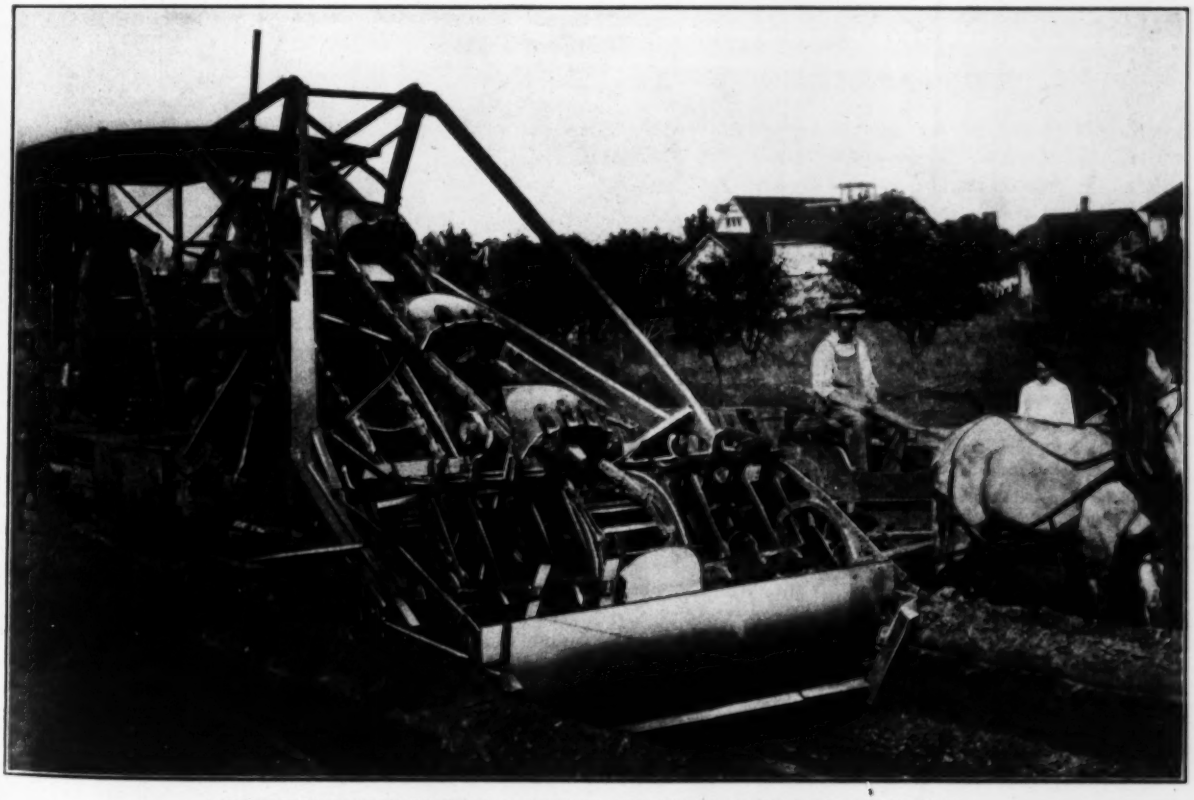
Excavating a cut 8½ ft. wide at one passage is the special feature of the excavator shown in the accompanying view. The machine is intended particularly for grading streets and street railways, where space is limited and where the material must be removed in wagons.

The excavating machinery consists of a horizontal drum 8½ ft. long and a chain of buckets. The portions of the drum beyond the buckets are fitted with teeth to loosen or excavate the machine; they have also spiral or diagonal blades 4x12 in., which are set at such an angle as to feed the excavated material toward the center, within reach of the buckets. From the buckets the material falls upon a lateral belt conveyor that delivers it to the wagons. The machine is 40 ft. long, with a maximum width of 9 ft., and weighs about 14 tons in running order. It is driven by a four-cylinder Buffalo gasoline engine of 24 hp.

The excavation can be done for depths ranging from 2 or 3 in. to 5½ ft. The cutter chain works on a boom that is adjustable by a screw, and an indicator is provided so that the operator can raise or lower the boom as required to keep to the grade line. It is found desirable to excavate slightly below the finished grade and then to dump sufficient material from wagons and roll it to grade. This is cheaper than to keep the cut above the grade line and then trim it down by hand labor.

For street work it is best to make the outside cuts first, cutting to a line to allow room for the curb and gutter and the concrete forms. On these side cuts the excavator is pitched to conform to the crown of the street, but on the center cut it runs level. Where the total width is a little over the 25½-ft. cut made by the machine (in three passes), the center cut is made a little deeper, so that the excess material on either side can be leveled down to fill the bottom of the cut and be rolled to grade. At alley intersections the cut is taken out to a greater depth for a distance of 16 to 24 ft., and then the material in the intersections is plowed and shifted into the cut with slip scrapers.

In excavating for street-railway track, where the trench is usually 8½ ft. wide and 18 to 20 in. deep, the cut is made in one operation. The machine will excavate old macadam paving if the cut can be made



NEW EXCAVATOR MAKING A CUT 8½ FT. WIDE FOR STREET GRADING